9.4.7 Right-of-Way and Utilities

This sections deals with determining right-of-way needs, acquisition of right-of-way, provisions for moving or accommodating utilities, right-of-way and utility plans and acquisition of material sources.

Since the Federal Lands Highway Division offices work with so many different roadway owners and operating agencies, only general guidelines are provided. It is not practical to prescribe detailed procedures and methods applicable to all situations relating to right-of-way, utilities and material sources.

9.4.7.1 Right-of-Way

The land that a highway occupies is the right-of-way. It consists of the land owned by the operating agency or land that the operating agency has a right to use for roadway purposes.

The right-of-way plans are official documents used to acquire real estate and property rights. The plans are often references for legal instruments (e.g., deeds, other documents conveying land or interest in land to various parties). The right-of-way staff assembles data and prepares plans for the acquisition of right-of-way, including easements, permits or any other substantiating documentation necessary. The final plans must be correct from the engineering standpoint and meet FHWA legal requirements and those of the highway agency acquiring the right-of-way.

9.4.7.1.1 Determining Needs

There is a basic conflict between the use of land for right-of-way and other uses. The right-of-way should provide for maintenance, control of access, utilities, future widening and control of adjacent drainage and vegetation for ensuring sight distance and aesthetics. The same land is often desirable for dwellings, farming, commercial or recreational purposes. Hence, a right-of-way is seldom ideal but is usually a compromise.

Establishing right-of-way widths can usually begin as soon as the earthwork design is substantially completed. The minimum right-of-way width is the horizontal distance from the centerline to the edge of clearing. It is always desirable to provide some additional area to accommodate minor changes in construction and to provide space for normal maintenance operations.

The clear zone recovery area should receive consideration when establishing new right-of-way limits. Good engineering judgment is essential in this area to determine when taking a prudent right-of-way equals the need for a portion of the theoretical recovery area.

It is not mandatory to provide right-of-way for new utilities. However, it is the usual practice to accommodate them when they do not conflict with the primary function of the roadway.

Construction often causes the relocation of utilities located with the existing right-of-way. It is a requirement that the new right-of-way must provide areas for their relocation.

Poles or other surface utility relocations should be beyond the clear zone area or behind guardrail. Place underground utilities in the road shoulder, beneath the ditch or preferably outside the right-of-way line. Pole lines usually require a minimum of 5 m (16 ft) of width to accommodate the cross arm and anchor systems and to provide for control of vegetation under the wires.

Sometimes there is a need to have drainage control structures, channel changes, riprap, stilling pools, etc., constructed above or below the roadway. It is desirable to have these structures within the right-of-way so there is no question of the right to maintain or rebuild them. The right-of-way should extend at least 3 m (10 ft) beyond these facilities. It is preferable to obtain right-of-way to cover these installations but in some cases a construction easement may suffice.

States, counties and other cooperating agencies generally have standard widths for highway right-of-way. Contact the highway-operating agency to determine the standard minimum widths and any other applicable criteria.

9.4.7.1.2 Right-of-Way Widths

Following the placement of slope limits on the detail map, work can begin on setting right-of-way limits. This assumes the designer knows the standard minimum widths and the desirable distance from the clearing limit to the right-of-way line.

The designer should keep the following in mind when establishing the final limits:

- It is desirable to have a uniform right-of-way width throughout each ownership for ease in locating fences and describing right-of-way.

- It is desirable to keep changes of right-of-way width to a minimum. Consider keeping the minimum length of constant width along centerline to 60 m (200 ft). Change widths when the right-of-way width needs changes by more than 5 m (15 ft) over a length of 60 m (200 ft).

- Change right-of-way widths at property lines, if practical, to simplify legal description of right-of-way.

- Change right-of-way widths at even stations or at curve points. To make a symmetrical fence line, it may be necessary to change widths at 20 m (50 or 100 ft) points or other odd stationing.

- Changes in width should taper from point-to-point except at property lines. Use a minimum of 15 m (50 ft), preferably 30 m (100 ft), along the centerline to avoid abrupt angles in the right-of-way line. This makes it easier to build and maintain right-of-way fences and to mow and care for right-of-way plantings.

- Provide stopping sight distances at intersecting road approaches and provide right-of-way to maintain these sight distances. This is mandatory at all grade crossings of railroads.

9.4.7.1.3 Right-of-Way Plans

A State or cooperating agency acquires almost all right-of-way for Federal road projects. As such, the format for right-of-way plans varies between the different acquisition agencies.

In some instances the cooperators prefer to prepare their own right-of-way plans and only require a completed detail map with slope limits and all known property ties. In other areas, Federal Lands Highway Division offices are responsible for the acquisition of right-of-way. The following discussion provides the guidelines and recommendations that cover the preparation of plans.

Before developing the right-of-way plans, obtain title reports, copies of deeds and any other documents about existing right-of-way. In some cases, the acquisition agency will perform this function.

Examine the documents for easements or other encumbrances to reveal the existence and location of waterlines, conduits, drainage or irrigation lines or other features affecting construction.

The relocation plan prepared during the conceptual stage is available to the right-of-way designer for information and implementation when it is applicable to the project. If the plan is outdated or significant changes have occurred within the project corridor, it may be necessary to prepare a supplemental relocation study. The study should show how occupancy needs are to be correlated with specific available and suitable housing. Typically, the right-of-way designer can request this information from the State or cooperator by working through the appropriate FHWA Federal-aid Division office.

Resolving the right-of-way plan format and obtaining current title reports and other documentation opens the way to preparation of the actual right-of-way plans. Completed right-of-way plans generally consist of four elements:

- Title Sheet,
- Tabulation of Properties,
- Vicinity Map and/or Ownership Map, and
- Right-of-Way Plan Sheets.

The basic information required on all right-of-way plans is found in *FAPG* NS 23 CFR 630.B. The following supplements the instructions in the *FAPG*.

A standard construction type of title sheet, modified to reflect right-of-way criteria, may be used provided it is acceptable to the acquisition agency. All the information that normally shows on a construction title sheet can appear on the right-of-way Title Sheet.

Most projects require a vicinity map or total ownership parcel map. The map scale used should be suitable to show the entire project on one plan sheet. It should also show general information to depict the project in relation to surrounding communities, public and private road systems and other local features.

Many States use the vicinity map to show ownerships and parcel numbers. This is often shown in tabular form with column headings as follows:

- parcel numbers,
- recorded owner,
- total assessed ownership,
- right-of-way required,
- existing right-of-way,
- remainder (left and right), and
- easements (permanent and temporary).

Minor variations of this tabular format will occur depending on the acquisition agency's practices, but the column headings shown seem to be consistent with most agency policies. It is usually permissible to place the parcel tabulation on a separate plan sheet if the vicinity map becomes too detailed. Some agencies show the parcel tabulation on the individual plan sheets rather than the vicinity map. It is difficult to go wrong if the vicinity map follows the format of the applicable agency manual. This is essentially true if the project is on a county road system or a State system.

In addition to the requirements of the vicinity map and other right-of-way documents, the following data is shown on the right-of-way plan sheets.

1. **Alignment**. Show the base line that legally describes the right-of-way as a continuous solid line for the full length of the project including alignment data. Existing or additional centerlines show as dashed lines with or without alignment data as appropriate. Tie the existing stationing to the new centerline by station and/or bearing equations.

2. **Control Features**. In addition to the culture tie requirements of Chapter Five, identify on the plans all Government subdivisions, platted subdivisions, donation land claims, National Park or Forest boundaries, Indian reservations or farm units.

   Show a minimum of one tie from the new highway centerline to an existing and recorded monument or government subdivision, particularly the monument from which the title report originates. Compute the tie to a centerline intersection along the section subdivision line with a station, bearing and distance to the monument.

   Frequently, it is necessary to resolve the issue of appropriate evidence of property lines for purposes of right-of-way activities. The property line could be a fence, ditch, partial section boundary (1/16) or the line described in the property deed. Locate, reference and show on the plans all topographic features (e.g., fences, ditches, roads) relating to property usage and boundaries. These topographic features are shown on the plans as

they actually exist in the field. The property line is determined and designated from this data for right-of-way requirements.

3. **Right-of-Way Details**. Right-of-way lines are continuous. These lines cross city streets, county roads, rivers, railroads, etc., and must match adjoining projects.

   Show enough detail to describe the right-of-way for its entire length from a centerline or from a metes and bounds description. Tie any existing right-of-way retained for the new project and describe it from the new centerline or by metes and bounds description. Ties to a previous centerline are not acceptable.

   Only deeded land for right-of-way is always supportable in a court of law. Right-of-way by usage or prescription is in many cases not legally supportable. Therefore, when deeded right-of-way does not exist, neither the existing right-of-way nor the centerline of the existing road need be tied to the new road alignment and/or the new right-of-way.

   Right-of-way widths and centerline stationing must be shown at the beginning and ending of each plan sheet and at all points of change in right-of-way width. Any easements required outside the right-of-way must show permit descriptions. These easements will accommodate intersecting roads and streets, land service, access and temporary roads, drainage areas, material storage areas, slope widenings, utilities, railroads and other special uses.

   Show centerline station at the beginning and end of each easement. Mark each easement as temporary (T) or permanent (P). If the easement is irregular in shape, include distance and bearings for writing a description.

   Temporary construction easements give permission to use the land for a brief time (e.g., during construction). Use permanent easements where parties other than the owner need to maintain a right to the land (e.g., a pipeline, an access road).

   Assign a parcel number to each recorded ownership for properties involved on each project. This includes all units of government. As a rule, number parcels starting with the first tract crossed by the project and then continue in sequence through to the end of the project.

4. **Access Control**. The highway-operating agency regulates control of access between a highway facility and all other property. When acquiring access rights, access control lines and all approved points of entry or exit from the traffic lanes must show on the plans. An access control line may or may not be coincident with the right-of-way line. Several types of access control, ranging from minimal to full control, may exist within the project limits.

   When the access control agency permits individual road approach entries from adjacent properties, identify them on the plans by symbol or type including stationing, width and grade.

9.4.7.1.4 Coordination with Acquisition Agency

Every highway agency responsible for acquiring right-of-way has a format and style that suits their method of operation. The right-of-way staff should meet with the acquisition agency early in the design process to determine the format and style acceptable to all parties.

The following general topics also merit discussion and resolution during the preparation of the right-of-way plans:

- How should property lines and ownerships be shown on the plan sheets?
- Can construction plans and right-of-way plans be combined? For separate right-of-way plans, is it necessary to have profile grade plan sheets? Are Federal-aid Plan and Profile Sheets adequate or are separate sheets necessary?
- What is the policy for need, type, placement and installation responsibility for right-of-way fencing?
- When the agency acquiring the right-of-way is also responsible for utility relocation agreements, what additional requirements are necessary to complete the plans?
- What is the process for modifying right-of-way plans after the acquisition agency has given final approval to the plans?

Sometimes the cooperating agency requests FHWA to furnish descriptions of the right-of-way needed. Sometimes the request is for a metes and bounds description.

9.4.7.1.5 Right-of-Way through National Forest Lands

In those cases where the acquisition agency and the Forest Service request that FHWA prepare right-of-way plans over National Forest Lands, the above plan preparation instructions apply. When the cooperator is a State highway agency, the right-of-way plans should comply with the Memorandum of Understanding (MOU) between the State and the Forest Service. When the acquisition agency is a county or other local government entity, the State Highway Agency may assist the county in obtaining the appropriate easement deeds for the highway construction. The process will be expedited and function quite smoothly if the designer coordinates the procedures through the appropriate FHWA Federal-aid Division Right-of-Way office.

Monumentation of the final right-of-way through National Forest Land, if requested, should be in conformance with the Memorandum of Understanding between the State and Forest Service.

9.4.7.1.6 Right-of-Way Acquisition

Right-of-way acquisition must be in accordance with the *Uniform Relocation Assistance and Real Property Acquisition Policies Act* of 1970.

Send the final right-of-way plans and supporting documentation to the agency responsible for acquiring the right-of-way and request them to proceed with the acquisition process. Although not mandatory, it is desirable that the plans and request for acquisition be sent through the appropriate FHWA Division Administrator.

It is also desirable to hold a field review of the right-of-way as proposed. All attending parties should resolve responsibility and timing for the various right-of-way clearance activities. Discuss the schedule for clearances, monitoring activities, contact personnel, delegation of authority and related matters and record the decisions from the field review.

Upon receipt of the right-of-way agreements from the acquisition agency, the right-of-way designer must ensure that all negotiated items (e.g., fences, cattleguards, road approaches, building relocations) are properly noted on the construction plans and rough draft Special Contract Requirements prepared.

When the State or other cooperating agency cannot obtain the right-of-way by purchase, it is often obtained by condemnation under the right of eminent domain. This is a time-consuming procedure as well as one having some legal ramifications. Therefore, when the State or cooperating agency reports that condemnation is likely, the designer shall review the plans for possible line shifts or other modifications to eliminate the need for condemnation.

When right-of-way is condemned, the usual procedure is to get a right-of-entry to the land by a court ordered declaration of taking so construction can proceed. The court will determine the following:

- if the need for the right-of-way exists,
- if its use will serve a public purpose, and
- that the landowner receives payment for the land.

The court requires the acquiring agency to post funds with the court equal to the estimated value of the property. At a later time the court, usually by jury trial, determines the value of the right-of-way and requires the acquiring agency to pay this sum to the landowner. The court then transfers title of the right-of-way to the acquiring agency by court order.

In these cases, the designer will record the status of the right-of-way as being under condemnation and will not approve the project for construction without at least a right-of-entry document.

For projects requiring a housing or business relocation, obtain a statement from the State or cooperating agency that relocation assistance was provided or tendered. This procedure is mandatory and is normally part of the right-of-way certification furnished by the acquiring agency.

Construction easements grant the right to construct supporting elements of the project outside the normal right-of-way on private land. The State or cooperating agency acquires them in the same manner as right-of-way.

Often there is the need for a construction easement after the project is underway. In these cases, the project engineer may work with the designer to document the need for the construction easement and to locate it. The designer prepares a description of the construction easement and requests the State or cooperating agency to obtain it.

FHWA may obtain some construction easements (e.g., temporary haul roads, stockpile sites, material sources) directly from a landowner. These are special cases and are done only when the cost to FHWA would be the same or less than if obtained by the State or cooperating agency.

9.4.7.2 Utilities

FAPG CFR 645A and *FAPG* CFR 645B provide policy and guidelines on adjustments to utilities. The highway operating agencies have various degrees of authority to designate and to control the use of right-of-way acquired for public highway purposes. Their authorities depend upon State laws or regulations. Utilities also have various degrees of authority to install their lines and facilities on the right-of-way.

The general policy is that utilities can occupy the right-of-way if they do not conflict with the integrity, operational safety or functional and aesthetic quality of the highway facility.

The term utility means all privately, publicly or cooperatively owned lines, facilities and systems for producing, transmitting or distributing communications, power, heat, petroleum products, water, steam, waste and storm water not connected with highway drainage. Other services that directly or indirectly serve the public and are also considered utilities include cable television, fire and police signal systems and street lighting systems. It also means the utility company is inclusive of any wholly owned or controlled subsidiary.

When irrigation districts or companies perform work at Federal expense, treat them as utilities.

9.4.7.2.1 Determining Relocation Need

The initial contact made with the utility company by the right-of-way staff is in the form of a letter shortly after the design work begins. The letter must outline the proposed construction project, its length, termini and other pertinent information that could affect the utility company (e.g., a tentative construction schedule). In some cases, a small scale map may be helpful for describing project limits.

The utility companies should provide, when requested, plat maps of the project area showing the location of all existing facilities above and below the ground level. The letter of request should also state that the utility company will receive construction plans later, showing existing utility facilities.

The designer will note the following types of utility conflicts during the design:

- Those utilities that are in the way of actual road construction. These could be poles or buried facilities within the construction limits or buried lines exposed or damaged by construction operations.

- All hazardous utility objects above groundline within the desirable clear zone. Those objects within the clear zone but located in back of nontraversable cut slopes, behind guardrail or impact attenuators or having breakaway features may not require relocation.

- Any utility installation not conforming to the aesthetic quality desired in the appearance of the highway and its environment.

9.4.7.2.2 Determining Responsibility for Utility Relocation

When the alignment and grade are firm, the designer shall check the plans and outline the utilities that may require relocation or adjustment.

The plans indicate responsibility for the utility adjustments. This could be government, utility or a combination.

When determining the responsibility for utility adjustments, identify each utility conflict on the preliminary plans. Color coding and/or symbols can be helpful in making proper identifications. A tabulation sheet showing conflicts by utility companies will help the designer.

Determine financial responsibility using these guides:

- When the utility occupies the existing highway right-of-way, the government's share of relocation cost is dictated by applicable State law. This ranges from zero percent in most states to up to 100 percent in a few States.

- When the utility occupies government land (e.g., land administered by the Forest Service, National Parks, Bureau of Land Management), all relocation cost is usually borne by the utility. This requires checking with the land management agency. There are cases when the utility has occupancy rights that require the government to share in the cost of adjustment.

After establishing financial responsibility, the designer shows on the preliminary plans the method used to make the required utility adjustment. One way to accomplish this is to show on the plans at each location where conflict exists, the following information:

- identify who is to move the facility (i.e., utility company, FHWA, State);
- identify location (i.e., stationing, left or right of centerline); and
- identify who will pay for the relocation (i.e., utility company, FHWA, State).

A system of symbols can show the same information. In addition, some method of noting joint use of utilities (i.e., power and telephone lines on the same poles) is desirable for use on the plans.

There will also be cases where the utility move will be a combination of utility and government expense. This covers instances where the utility is on existing right-of-way and would only need to move a short distance for construction purposes. However, FHWA wants them to move a greater distance for other purposes (e.g., aesthetics, clear zone requirements).

The plans developed for construction or right-of-way may be adequate for utility plans. The essential information needed on utility plans includes the following:

- centerline;
- construction limits;
- existing and proposed right-of-way;
- edge of existing road;
- all utility installations;
- easement, permit and utility ownership data;
- depths of underground facilities and elevations of all crossing wires less than 13 m (43 ft) in height from the proposed grade line; and
- the proposed utility construction necessitated by the highway improvement project.

Send a letter and plans to the utility companies inviting them to a field inspection.

It may be prudent to provide the utility companies with a copy of *FAPG* CFR 645A and *FAPG* CFR 645B along with the preliminary plans. This is particularly true if the utility is a local entity and not familiar with their rights and obligations under FHWA policy and procedure.

In each letter inviting the utility companies to a field inspection, insert the following paragraph:

> *Your company's preliminary engineering costs for plan preparation and estimating costs of the utilities to be removed, adjusted or relocated at FHWA expense are eligible for reimbursement after date of this letter.*

At the field review with the utility company's representative, discuss the following areas of mutual interest and resolve any conflicts to the extent possible. The following provides some examples of possible conflicts:

- Are all the utilities requiring adjustment shown on the plans?
- Has the financial responsibility for the utility adjustment been mutually determined?
- Will the utility build the new relocated facility before cutting the existing one or can service be discontinued until the existing facility is moved to its new location?

- How long will it take to move the utility?
- What advance notice does the utility require before it performs the work? (The ideal situation is to have all utility adjustments completed in advance of roadway construction.)
- Do requirements for temporary traffic control plans conform to the applicable standards in the *MUTCD*?
- Is there evidence of the utility company's right-of-occupancy?

The designer will document oral agreements made at the field review. The report should note the name and organization of those in attendance, the names of contacts during development of the utility plan and any problems pertaining to facility relocations. The utility should receive a copy of the plan and any problems pertaining to facility relocations. The utility should receive a copy of the report.

Invite the highway agency responsible for permitting the utility to use a portion of the right-of-way to all field reviews and keep them informed of all developments. When the utility is on government land, involve the administrating agency in the utility relocation.

Following the field review, work with the utility's representative to determine the adequacy, practicality and economic reasonableness of the portion of the relocation eligible for reimbursement by FHWA. This involves checking the utilities' relocation plans and reviewing their work estimate for accuracy and cost effectiveness.

The evidence of the right of occupancy submitted by the utility requires a check to determine its validity. The evidence may be a letter giving the numbers and/or identifying the use permit or a statement that the utilities are on private right-of-way or easements. If there is any question, check the permits through the applicable agency. The utility right-of-way easement over private property can be checked through the county records of deeds or assessments.

On approval of the utility relocation plan, the designer will transfer the information onto reproducible plan sheets to make copies for the utility agreement, if applicable.

The government requires a utility agreement when any portion of the relocation costs are eligible for reimbursement. When the relocation costs are borne by the utility, the right-of-way staff will furnish plans, coordinate activities and review the utility's proposal for compatibility with construction and safety requirements.

A utility agreement is a three part document consisting of the following:

- Utility Project Agreement Form,
- cost estimate, and
- plan sheets.

When the rough draft of the agreement is complete, obtain the contract number from the Planning and Coordination Unit and request that they obligate the required funds. When

notified that funding is clear, complete the preliminary agreement including cost estimate and plans.

Send a copy of the utility package (include occupancy permits, when applicable) to the cooperating agency with responsibility for its use. The responsible agency is usually the State highway organization of the county. When the relocated utilities fall within the Forest Service boundaries, send a copy to the Forest Supervisor's Office for review. The FHWA Division Office may want the opportunity to review the package to ensure that the proposal does not conflict with policy agreed to with the State.

When all the review comments are resolved, complete the final agreement package. The original and two copies of the final agreement requires signatures before they can be forwarded to the utility. The utility should return two signed copies. Distribute the signed copies and all necessary confirmed copies in accordance with office procedures.

Prepare a utilities packet for the project engineer consisting of the following:

- a copy of the agreement with exhibits;
- copies of letters of memoranda dealing with the utilities;
- copies of reports of field trips or meetings; and
- discussions of procedures or actions needed (e.g., traffic control, disruption of service, coordination of contractor and utility company operations, safety).

The utilities packet is given to the appropriate construction staff for forwarding to the project engineer.

The Construction Unit is responsible for verifying the utilities work. When the utility performs the work before the award of the contract, the Right-of-Way Unit is responsible.

After completion of the utility relocation and government verification of the work, make final payment to the utility company and record the work.

9.4.7.2.3 Location

Locate facilities to minimize the need for utility adjustment on future highway improvements. Avoid interference with highway maintenance and permit access to the facilities for their maintenance with minimum interference to highway traffic. Always consider clear zone requirements when making utility adjustments.

Locate facilities on uniform alignment as near as practical to the right-of-way line. On frontage roads, locate the facilities so that servicing may be performed from the frontage road.

Place facilities crossing the highway approximately at right angles to the highway alignment whenever possible and, preferably, under the highway.

9.4.7.2.4 Retention of Existing Facilities

Under certain conditions, AASHTO policy permits existing facilities encountered during highway construction to remain in place. Facilities deviating from this policy may remain on the highway right-of-way when it is in the public interest and will not adversely affect the highway or its users. This type of retention will be with the understanding that compliance is mandatory when the facility is reconstructed.

When crash history or safety studies show that existing facilities are hazardous, relocate or shield them regardless of prior agreements with the utility. Changes in operating conditions of existing facilities, other than for routine maintenance, require a new permit from the highway operating agency before initiating any work or change.

9.4.7.2.5 Aesthetic Controls

If practical, place cluttered overhead facilities underground. The design of facilities should minimize any adverse visual impact and should be planned to preserve attractive landscapes.

New utility installations, including those needed for highway purposes, are not permitted on highway right-of-way or other lands acquired by or improved with Federal funds within or adjacent to areas of scenic enhancement and natural beauty. These types of areas include public parks and recreational lands, wildlife and waterfowl refuges, historic sites as described in 23 USC 138, scenic strips, overlooks, rest areas and landscaped areas.

New underground utility installations must not cause the extensive removal or alternation of trees visible to the highway user or impair the visual quality of the area.

Avoid new aerial installations unless there is no feasible and prudent alternative to the use of these lands and only if the following can be established:

- Other utility locations are not available, are unusually difficult, are unreasonably costly or are less desirable from the standpoint of visual quality.
- Underground installations are not technically or economically prudent or are more detrimental to the visual quality of the area.
- The location and installation of the proposed facility will not significantly detract from the visual qualities of the area being traversed. The facility will employ suitable designs and materials to enhance aesthetic values.

No service connections are permitted to cross freeways when a distribution line is available within a reasonable distance on the same side of the highway as the premises being served. Keep crossings of other highways and streets to a minimum.

Facilities to be located on or across highways having easements (e.g., Forest Service land, Bureau of Land Management land, railroad land) require the approval to those agencies.

9.4.7.2.6 Utility Installations on Highway Structures

Avoid utility attachments to bridge structures whenever possible due to a potentially negative effect on safe traffic operation, efficiency of maintenance and appearance. In those cases where alternate locations are not practical, the method of attachment should meet the following requirements.

- Make sure the bridge design is adequate to support the additional load and accommodate the utility without compromise to highway features, including maintenance.
- Do not allow manholes in the deck.
- Locate the utility beneath the deck between outer girders or beams or within a cell in a position that provides adequate vertical clearance. Avoid any attachments to the outside of bridges.
- Attachments made by support rollers, saddles or hangers are acceptable when padded or coated to muffle vibration noise. Make attachments below the deck but do not allow bolting through the bridge floor. The design of the attachment device requires review and approval before installation by the bridge unit.
- Pipes and conduits carried through abutments should be sleeved and tightly sealed with mastic. Upon leaving the bridge, align the utility to the outside of the roadway in as short a distance as practical.
- Provide for linear expansion and contraction due to temperature variation by use of line bends or expansion couplings.
- Provide for shut-off valves, either manual or automatic, at or near ends of structures to provide a means of control in case of emergency.
- Provide suitable protection to prevent corrosion.
- When a pipeline is cased, vent the casing at each end to prevent possible buildup of pressure and to detect leakage of gases and fluids.
- When a pipeline attachment to a bridge is not cased, additional protective measures should be taken. These measures include using a higher factor of safety in the design

and construction and testing of the pipeline than would normally apply for cased construction.

- Communication and electric power line attachments should be suitably insulated, grounded and, preferably, carried in protective conduit or pipe from the point of exit from the ground to the point of reentry. Carrier pipe and casing pipe should be suitably insulated from electric power line attachments.

9.4.7.2.7 Overhead Power and Communication Lines

In rural areas or on urban highway sections having the same design standards and other characteristics of rural highway, above ground facilities must be located outside the clear zone. When circumstances warrant a lesser distance, facilities installed closer than other roadside appurtenances are not acceptable. It is ideal to locate all fixtures as near as possible to the right-of-way line.

A variance to maintain a reasonably uniform pole alignment is allowable when irregularly shaped portions of the right-of-way extend beyond the normal right-of-way limits. Excepted from these controls are poles or other ground-mounted appurtenances required for highway lighting. However, where possible, poles and appurtenances must be serviced by underground cable and designed to include a breakaway pole.

When right-of-way is not sufficient to allow installation beyond the clear zone, place the facilities to minimize the hazard to an out-of-control vehicle (e.g., behind the guardrail).

On urban sections with posted speed limits of 60 km/h (35 mph) or less, it may not be practical to locate poles and ground-mounted appurtenances beyond the curb or to protect them with guardrail. However, locate the facilities as far as practical behind the curb or outside the shoulder and/or parking area if there is no curb.

Minimum vertical clearance for conductors must meet the requirements of the *National Electrical Safety Code* or applicable local codes. When codes conflict, use the code requiring the greater clearance.

9.4.7.2.8 Underground Electric Power and Communication Lines

Longitudinal installations located within the foreslope limits are acceptable. This is true only if an installation outside the ditch line would be extremely difficult or costly; or if the highway traverses a scenic area where an aerial installation would detract from the view; or if placing buried cable beyond the ditch line would require removal of trees and shrubs.

Locate installations placed within the foreslope limits a uniform distance from the pavement edge and as near as practical to the inside edge of the ditch. Do not place buried cable within 600 mm (2 ft) of a ditch line. The installation shall normally be as near to the right-of-way line as practical while maintaining a uniform distance from the highway centerline.

Locate all crossings as normal to the highway alignment as practical. Avoid crossings in deep cuts, near footings of structures, at-grade intersections or ramp terminals, at cross drains and in wet rocky terrain.

Pedestals or service poles installed as part of a buried installation generally are placed 300 mm (1 ft) from the right-of-way line. Never locate pedestals within the highway maintenance operating area, including mowing operations.

Lines (i.e., cables) without encasement require a minimum bury depth of 750 mm (2.5 ft), except to clear an obstruction (e.g., a drainage facility). Then the depth may be reduced to 600 mm (2 ft). Encased lines buried less than 600 mm (2 ft) are acceptable provided the encasement does not protrude into roadway base course materials. Encasement and installation must conform to the applicable cooperator and/or utility company provisions.

Identify all buried cable locations by placing standard warning signs (i.e., markers) at the right-of-way lines for the crossings. Longitudinal installations require markers at appropriate intervals; however, for electric power cables, this interval must not exceed 150 m (500 ft). The markers must be offset as near the right-of-way line and practical.

9.4.7.2.9 Irrigation and Drainage Pipes, Ditches and Canals

Bury irrigation line and pipe siphon crossings from right-of-way line to right-of-way line or from edge-of-clear zone to edge-of-clear zone, whichever is greater.

When crossing a roadway, water canals and irrigation ditches can pass through culverts or bridges. Open channels or ditches should not be parallel to highways within the clear zone. It is preferable to locate these outside the right-of-way limits.

9.4.7.3 Railroad Encroachments

The processing of railroad agreements and the preparation of plans for railroad encroachment projects usually are time consuming operations. The designer should initiate this process at an early stage to avoid delaying the development of the project.

Railroad agreements are three party documents between the cooperating highway agency, the affected railroad company and the Federal Lands Highway Division. The responsibilities and obligations of each party must be spelled out in detail in the jointly signed agreement. There is no rigid format for preparation of the agreement but items needed in every agreement are spelled out in *FAPG* 23 CFR 646B.

In general, right-of-way is not acquired in fee from a railroad company. Instead, the highway operating agency acquires easements, access rights, temporary easements, encroachments, etc. for highway construction.

The cooperating highway agency or the affected railroad may prepare the actual agreement. However, it requires review and approval by all three parties. When it is agreeable to all parties, the construction may proceed on the basis of a right-of-entry permit with the actual details of formal agreement being resolved during the construction phase.

Each State usually has a procedure and guide to clear their projects through the appropriate railroad channels. The designer should contact the cooperating highway agency for additional guidance.

9.4.7.3.1 Pre-Survey

It is best to define the scope of the project by conducting an on-ground joint inspection of the site with railroad engineering staff, the State or highway operating agency and other interested parties before starting a survey.

If possible, obtain a recent railroad map of the site indicating railroad right-of-way for the meeting.

This review should clarify other railroad company policies on these topics:

- the closest encroachment to the centerline of tracks permitted;
- sight triangles;
- traffic maintenance (detours);
- drainage, bank protection or other conditions to be encountered on the proposed highway location; and
- railroad work schedules.

9.4.7.3.2 Cross Sections

When a highway encroaches on railroad right-of-way, extend the cross sections across the railroad tracks at sufficient intervals to show the relationship between the finished highway grade and the railroad tracks. Have the cross sections taken in critical areas of the greatest encroachment and elevations taken at the top of rail.

Cross section each railroad structure and record the type of structure, the opening length and other information for comparison with railroad map. This information will help determine whether the structure needs extending or replacing.

The survey should tie all railroad or other utility poles and any facilities located on the railroad right-of-way that could affect the design. Proposed utility adjustments must be shown along

with their ownership. Show all utility poles and vertical clearance of utility lines at grade crossings.

9.4.7.3.3 Horizontal Alignment

The designer locates highway centerline in the same manner as any other location with the following modifications:

- Show ties to the centerline of the railroad company's main track at each end of the encroachment area and at the beginning and the ends of the curves on the railroad. With this information, compute the bearings of the railroad tangents using highway data.

- Accurately locate railroad facilities (e.g., head blocks, front face of depot, drainage structures, bridges) so that stationing will check with railroad plans.

- When the proposed highway crosses over the railroad centerline, make a tie showing highway station reference and railroad station reference with the angular tie between the two. Take a cross section at the intersection of the highway and railroad centerlines.

9.4.7.3.4 Vertical Alignment

In most cases, the profile of the highway project will satisfy railroad requirements. However, at crossings, take the top of the rail elevation at centerline and edge of proposed roadway for each rail. This allows easy correlation between highway finished grade at the centerline of the railroad with the railroad elevation at the intersection.

For a highway grade separation structure located above a railroad, obtain the following data:

- railroad alignment data (all tracks),
- elevation of top of rail for each track system at centerline of highway, and
- profile of each rail (top) for 150 m (500 ft) each side of highway centerline.

9.4.7.3.5 Plan and Profile Sheets

The railroad stationing and curve data, including beginning and ending of the curves through areas affected by encroachment or crossing, must be shown on the highway plans.

Show on the plans all railroad and highway right-of-way lines and widths, including easements. Compute the ties at right angles from the highway centerline and show all intersecting corners of the right-of-way. Show the ties at the beginning and the end of each encroachment and at the points of maximum encroachment.

Show all railroad drainage structures and other topographic data pertaining to railroad buildings, head blocks and other points of control.

Furnish profiles for proposed special drainage or waterway channels to give the railroad company a more complete picture.

An adjustment in the railroad line (e.g., raising or lowering tracks to accommodate highway construction) is occasionally necessary. In this case, a special profile along the railroad alignment will show the full extent of the raising or lowering of tracks. Carry the profile a sufficient distance outside of the adjusted area to give a complete picture of the proposed adjustment.

For a new crossing of the railroad tracks, prepare a special profile on either side of the crossing along the track centerline for several hundred meters (feet).

9.4.7.3.6 Cross Section Plots

Cross section plots prepared in elaborate detail are not necessary. However, for highways encroaching on railroad property, it is advisable to show all the data obtained in the field.

Computer generated plots are acceptable with the possible exception of partial sections for drainage and approach design. For drainage sections, furnish elevations for inlets and outlets of pipe as well as channel elevations upstream and downstream. Show size and length of all drainage or other type structures in existence and proposed on the new construction.

Show railroad and highway information, including superelevation and widening where applicable.

The cross sections are usually plotted on standard reproducible cross-section paper. Maintain ample space between cross sections to ensure legibility.

Show the railroad right-of-way lines on all cross sections. Make sure the distance shown on the cross section from the encroachment line to the railroad right-of-way will check the field ties shown on the plan sheet.

Show the railroad and highway culverts on the cross sections and include the flow line elevations. This allows the consideration of extensions rather than relaying an existing pipe or installing a new one.

Some projects require slope permits or ditch easements in addition to the regular encroachment. In these cases, the cross sections must show the railroad right-of-way line, the easement line, the sloping permit or channel change line.

When raising or lowering a railroad track is necessary for highway construction, plot cross sections along the centerline of railroad tracks through the area affected.

9.4.7.3.7 Final Assembly

Forward the completed plans, profiles, cross-section rolls and structure clearance, if applicable, to the owner agency and request their review and comments. A request to begin preparation of the formal agreement can accompany this submittal.

The final PS&E package review should ensure that the contract contains all conditions listed in the approved railroad agreement.

9.4.7.4 Railroad Grade Crossings

Before designing improvements in the vicinity of existing crossings or new crossings, arrange for a field inspection of the crossing site. The review should involve appropriate Federal, State, local and railroad representatives. Even if no improvements are made to the railroad crossing, coordination is needed early with the railroad company in regard to temporary traffic control that may affect the railroad. These special considerations and coordination should also be clearly stated in the Temporary Traffic Control Plan and in the SCRs.

The review should resolve financial responsibility, scheduling and authorization to proceed with the work. The type, number and location or railroad signals to be installed should also be determined.

All utilities, both aerial and buried, in possible conflict with the proposed installation must be noted, including facilities interfering with the proposed railroad signals or gate installations requiring adjustments. In some instances it may be preferable to adjust the location of the railroad signals. Consider any proposed future highway widening project when determining placement of the signals.

Photographs taken during a field inspection are very helpful during the design phase of the project.

The function of traffic control systems is to permit safe and efficient operation of railroad and highway traffic crossings.

A Passive Traffic Control System includes signing, pavement markings and grade crossing illumination. Signing used at railroad grade crossings should include the following:

- A railroad crossing sign, commonly identified as the crossbuck sign. The crossbuck sign post will have a retroreflective strip on both sides, facing traffic. The railroad is typically responsible for placement and maintenance of crossbuck signs. Improvements may need to be made as part of the highway project.

- An auxiliary railroad crossing sign of an inverted T shape mounted below the crossbuck sign to show the number of tracks when two or more tracks are between the signs.

- An advance railroad warning sign.

- An exempt railroad crossing sign as a supplemental sign (when authorized by law or regulation) mounted below the crossbuck and railroad advance warning signs.

- A DO NOT STOP ON TRACKS sign.

Pavement markings placed in advance of a grade crossing on all paved approaches must consist of railroad pavement markings, NO PASSING markings for two-lane roads and stopping lanes, if needed.

Illumination of railroad crossings supplements other traffic control devices for nighttime railroad operations. Consider lighting where train speeds are low, where crossings become blocked for long periods, or where crash history shows that motorists experience difficulty in seeking trains or control devices at night.

Signals consist of post-mounted flashing light signals and cantilever flashing light signals and, where warranted, the addition of automatic gates. Any of the foregoing may or may not include a bell.

There is no single standard system of active traffic control devices universally applicable for grade crossings. An engineering and traffic investigation determines the type of active traffic control system that is appropriate.

Determine from Exhibit 9.4-W the level of crossing protection needed. Use these guides unless they conflict with State standards.

Signal installations will use the signals shown in the current edition of the *MUTCD* and the *Railroad-Highway Grade Crossing Handbook*. The locations of signals and automatic gates are shown in the *MUTCD*.

A railroad signal may be a point hazard that warrants the use of a traffic barrier or a crash cushion. Install all traffic barriers or crash cushions outside the minimum railroad clearance as shown in the *MUTCD*.

Truck and bus stopping lanes may be required at railroad grade crossings except for the following:

- any railroad grade crossing where a police officer or a duly authorized flagger controls traffic;

- any railroad grade crossing where a traffic control signal regulates traffic;

- any railroad grade crossing protected by signals, with or without an automatic gate; and

- any signed railroad grade crossing exempt under State law.

Type of Highway	Exposure Factor[1]	Type of Railroad Facility		
		Non-Mainline	Single Mainline (< 100 km/h (65 mph))	Double Track or High-Speed Single Mainline
Two Lane	Under 1500 1500 to 5000 5000 to 50 000 Over 50 000	Reflectorized Signs Flashing Lights Auto. Gates [2] Separation	Flashing Lights Flashing Lights Auto. Gates[2] Separation	Flashing Lights Flashing Lights Auto. Gates[2], Separation
Multilane	Under 50 000 Over 50 000	Auto. Gates Separation	Auto. Gates Separation	Auto. Gates Separation
All Fully Controlled Access	In all cases	Separation	Separation	Separation

Note:

1. Exposure Factor = Trains per day x vehicle ADT

2. Automatic Gates to be used in urban areas and flashing lights in rural areas, unless conditions warrant otherwise.

GUIDELINES FOR RAILROAD CROSSING PROTECTION

Exhibit 9.4-W

The stopping lane geometrics consist of the following:

- The approach taper to the stopping lane is 50 m (165 ft) long and the width may vary from 0 m to 3.6 m (0 ft to 12 ft).
- The length of the full width stopping lane is 30 m (100 ft) in advance of the centerline of the first set of tracks to 25 m (85 ft) beyond the last set of tracks.
- The acceleration taper is 60 m (200 ft) long and the width may vary from 3.6 m (12 ft) (full width) to 0 m (0 ft).
- The shoulder along the stopping lane is a minimum of 0.9 m (3 ft).

The decision to add stopping lanes is made on a project-by-project basis after review of the site and after determining legal requirements under the applicable State regulatory authority.

A good smooth surface is an important part of any railroad-highway grade crossing that contributes to the safety of crossing vehicles. Typical types of crossing surfaces for railroad/highway grade crossings follow:

- asphalt concrete,
- concrete,
- steel,
- timber,
- rubber (elastomeric) panels,
- linear high density polyethylene modules, and
- epoxy-rubber mix cast-in-place.

Any highway grade crossing lacking a demonstrated need should be obliterated and all traffic control devices and tracks removed.

On the design plans, show the basic roadway dimensions of shoulders, medians, traffic lanes, stopping lanes and acceleration lanes, including pavement marking requirements. Show the angle of crossing, number of tracks, location of signals and other railway facilities (e.g., signal power lines, signal control boxes, switch control boxes). The name of the railroad and whether the track is a mainline or branch line should be noted.

Sight distance is of primary consideration at grade crossings. The condition at a railroad grade crossing is comparable to that of intersecting highways where a corner sight triangle must be kept clear of obstructions. The desirable corner sight distance arrangement allows a driver approaching the grade crossing to see a train at such a distance that if the train proceeded without slowing down, it would reach the crossing about the time the highway vehicle can brake to a stop in advance of the crossing.

Plan and profile on both the railroad and highway should show for a minimum of 150 m (500 ft) on both sides of the crossing. Extend the roadway profile as necessary to show all important vertical alignment data. Also, show other important features that may affect the design of traffic operation of the crossings. These features include proximity of crossroads or city street intersections, nearby driveways or entrances, highway structures, vehicular ADT (including percentage of trucks and number of school buses) and train ADT.

If the railroad track is superelevated, the highway profile must conform closely to the grade across the top of the rails.

The plans must show the type of signals proposed, the length of gates and/or cantilever required and the number of signal heads and their facing direction. Also, show the exact location of the signal supports in relation to the railroad and highway centerline. Signal cantilever arms and gates are normally located perpendicular to the roadway centerline. Show all railroad facilities, signal controls, switch boxes and utility poles on railroad right-of-way in addition to those along the highway right-of-way. Pedestrian gates may be desirable in certain urban areas and need consideration in the design reviews.

Cantilever arms for signals are normally prefabricated in 600-mm (2-ft) increments. Determine the arm length for a four-lane road by measuring from the center of the inner lane to the desired support location. Have the end light units on the cantilever and on the pedestal installed back-to-back. Two-lane roadways do not normally require cantilevers except for unusual sight

distance problems. All post-mounted lights on two-lane roadways with truck and bus stop lanes should have a cantilever with light units installed back-to-back over the main traffic lane and on the pedestal.

Wooden gate arms are available in lengths up to 13 m (43 ft). Fiberglass arms up to 10 m (33 ft) and aluminum arms up to 12 m (40 ft) in length are also available. Longer lengths require prior approval by the railroad company involved.

Gates should end 0 to minus 300 mm (12 in) from the centerline of undivided roadways or from the near edgeline of the median on divided roadways.

Never paint two-way turn bays across railroad tracks. They shall end 30 m (100 ft) from each side of the railroad tracks with barrier striping across the tracks.

A typical section on the plans must show roadway and lanes widths, pavement markings for centerline and edge and lane lines. Simple lines for poles, arm and gate with circles for the required signal heads are acceptable on the typical section. Show the location of signal heads over the center of lane, height of cantilevers above the roadway and distance of the signal pole from centerline of travelway. Use only approved symbols.

The review of the preliminary plans and the procedure for requesting the cooperating highway agency to obtain the formal agreement for the proposed work is similar to the procedure discussed in Section 9.4.7.3.

9.4.7.5 Material Source Reclamation Plans

On FLH projects, all government designated material sources, except established commercially operated sources, require rehabilitation under an approved reclamation plan.

The reclamation plan must set forth measures to return the land to the most appropriate function following use of the source. The site may be reclaimed in a series of stage reclamation efforts when several projects designate the same source. Side borrow sites within the right-of-way do not require a reclamation plan.

The reclamation plan provides that reclamation measures, particularly those relating to control of erosion, be conducted simultaneously with surface mining. When this is not possible, initiate reclamation measures at the earliest possible time after completion or abandonment of mining on any segment of the site area.

The plan would normally include some or all of the following:

- A vicinity map describing site boundaries as shown on the right-of-way or sundry site boundaries and enough information to locate the site on quadrangle or county maps.

- Existing water forms and ground contours. Existing contours are optional unless the design or permit process requires them.

- Proposed finished ground contours and cross sections needed to show finished slopes.
- Statement of the proposed subsequent use of the land. Include any local zoning and planning requirements, any indications of whether the site is intended for use by other contractors or maintenance forces in the future and whether or not stage reclamation applies. For stage plans, provide interim reclamation measures that ensure an orderly depletion and restoration of the site. Scheduled staged use to reclaim the largest possible surface area under the final reclamation plan.
- Manner and type of revegetation and other surface treatment of disturbed areas.
- Preservation or establishment of visual screening and vegetative cover to screen the view of the operation from public highways, public parks and residential areas.
- Proposed practices to protect adjacent surface resources. This includes prevention of slumping or landslides on adjacent lands.
- Slopes that are blended with adjacent terrain to meet future use requirements. In all cases, provide for adequate safety.
- Method of preventing or eliminating conditions that create a public nuisance, endanger public safety, damage property or are hazardous to vegetative, animal, fish or human life in or adjacent to the area.
- Method of controlling contaminants and disposing of surface mining refuse.
- Method of diverting surface waters around the disturbed areas.
- Method of restoring stream channels and stream banks to a condition minimizing erosion, siltation and other pollution.
- Planned lakes, ponds or other bodies of water that would be beneficial for residential, recreational, game or wildlife purposes.
- Restoration of any borrow, quarry or pit site. Sites resulting in a lake or wetland involve careful planning and must take into consideration all factors impacting the fauna and flora.
- Proposed stockpiles of 10,000 metric tons or more.
- Permanent buildings and any protective stipulations required.
- Photographs whenever possible.

Federal Lands Highway Division will cooperate with other governmental and private agencies to provide land reclamation of the sites used for the described purposes.

Reclamation plans for sources located on Federal Lands require coordination with and approval by the agency responsible for administration of the land in accordance with the appropriate Memorandum of Understanding.

Reclamation plans for sources on private lands usually require coordination and approval by a State and/or local agency with responsibility for issuing and administering material removal operating permits.

9.4.8 Reviews

PS&E development involves various stages of review. The objective of a field review/plan-in-hand inspection is to ensure to the maximum extent practical that the location and design reflect and are consistent with Federal, State and local goals, objectives and standards.

All cooperating agencies and appropriate Federal Lands Highway Division staff should be invited to each field review. These reviews give the designer the opportunity to present the proposed design to the cooperating agencies and to solicit comments to ensure that the design is being developed in compliance with the intended scope and social and environmental commitments.

It also gives the designer the opportunity to verify data and check office proposals against field conditions to minimize construction concerns.

Field reviews give cooperating agencies a medium for free and open discussion that encourages early and amicable resolution of controversial issues that may arise during the development of the PS&E package.

The need for a field review to fulfill the stated objective depends on a wide variety of factors that cannot be predetermined even on a project-by-project basis.

The reviews may range from multi-disciplinary and multi-agency inspections to specialized on-the-ground meetings with a single discipline to resolve a specific problem. In all cases, the conclusions reached at the field reviews require documentation and distribution to the interested parties.

The designer is usually involved in at least three design reviews. The following applies:

1. **Preliminary Design Review**. The first review covers the preliminary design and results in approval of the major design features for a project (e.g., horizontal and vertical alignments, typical section, access control).

   The information available for this first review ranges from very little to completed detail maps and profiles showing preliminary alignments and plotted cross sections. This strictly depends on the scale of construction proposed (e.g., RRR to new construction).

At these early reviews, concentrate on resolving roadway geometrics, safety considerations, environmental mitigation efforts and cost effectiveness of the proposed improvement.

Emphasize any exceptions to standards along with the associated hazards so that the highway operating agency is aware of the ramifications of the decisions.

2. **Plan-In-Hand Design Review**. The second or plan-in-hand design review is to review preliminary plans and specifications for the proposed project. On some projects an intermediate review may not be necessary to complete the design. The primary purpose of this review is to finalize the design elements and other special conditions for inclusion in the PS&E package.

   At this second stage the preliminary design should conform with the governing criteria, including input from geotechnical and hydraulic reports, environmental documents, safety requirements and other matters pertinent to the project. Discuss those items affecting the plans or Special Contract Requirements and make arrangements for obtaining the necessary data.

   Following the intermediate design stage, the designer should prepare the final plans, Special Contract Requirements and complete the engineer's estimate for the project.

3. **PS&E Review**. The third stage in the process consists of the final plan-in-hand or PS&E review phase. After revising the plans and Special Contract Requirements to show changes from the previous reviews, the PS&E package is distributed internally for a final review by staff specialists to ensure consistency with programming, environmental, geotechnical, hydraulics, bridge or other project requirements. The PS&E package is also to be forwarded to interested agencies for their review and comment. Depending on the thoroughness of the previous reviews, an on-site inspection may or may not be required.

   In either case, resolve all comments received concerning the proposal. The end result of this final review phase is the solicitation of the contract package.

9.4.9 Plans

Plans consist of a series of drawings containing engineering data about the location, character and dimensions of the work, including layouts, geometrics, cross sections, structures and related details. The plans, together with the specifications, contain all of the data required for the contractor to submit a bid, stake and construct the project.

The overall size of plan sheets must be approximately 279 mm by 432 mm (11 in by 17 in). The standard size plan sheets provide approximately a 35-mm (1.4-in) margin for the binding on the left edge, a 7-mm (0.3-in) margin on the right edge and a 7-mm (0.3-in) margin on the top and the bottom. This provides an effective sheet size of approximately 265 mm by 390 mm (10.4 in by 15.3 in). For plotting purposes, the useable sheet dimensions may need to be slightly

reduced (e.g., 271 mm by 423 mm (10.7 in by 16.7 in) with 27 mm (1.1 in) left margin and 5 mm (0.2 in) margins on the right, top and bottom).

In some cases, “book size” plan sheets may be as small as 216 by 279 mm (8.5 by 11 in).

The organization of a normal set of construction plans is outlined in Section 9.6.1.2. The format for abbreviated plans is not detailed. The designer should consider the expected work and arrange the format accordingly.

9.4.9.1 Bridge Plans

The designer will usually receive a complete set of bridge plans and accompanying draft Special Contract Requirements for insertion into the PS&E assembly. The bridge plans and plan-profile sheets must be cross-checked to ensure that stationing, gradients, elevations and other geometric details are identical. The designer reviews the notes on the bridge plans and the draft Special Contract Requirements to eliminate any conflict with other provisions of the contract. Transfer quantities on the bridge plans to the summary sheet and assign item numbers as appropriate. Resolve any differences found during the review and number the bridge plans for insertion into the final package.

9.4.9.2 *Standard Drawings*

Standard drawings are designed for repetitive use and to provide uniformity of design and construction where the construction details are the same from project-to-project. Use standard drawings for culverts, minor drainage structures, guardrail and other items as appropriate. Local State highway agency *Standard Drawings* may be used where Divisions deem their use is more appropriate.

The Federal Lands Highway Office (FLHO) issues *Standard Drawings* for use in the Federal Lands Highway programs. *Standard Drawings*, together with the *Specifications*, contain all appropriate information that is necessary to describe the details of the proposed work. The FLHO maintains the *Standard drawings* and supersedes or withdraws those drawings that become obsolete or ineffective.

When a Division office must modify *Standard Drawings* for specific projects, they become special drawings and they no longer have typical standard drawing title blocks. To prevent confusion, title blocks for special drawings must be clearly distinguishable from the standard drawing title blocks.

The Division offices, or Functional Discipline Teams, periodically review FLH *Standard Drawings* and Division *Standard Details* for consistency with FLH *Standard Specifications* and with FLH policies, and industry best practices.

A Division office, FLH Functional Discipline Team, or FLHO may propose new *Standard Drawings* or revisions to existing *Standard Drawings* at any time. Division offices or Functional

Discipline Teams submit their proposals to the FLHO for consideration as summarized below. When it is determined that *Standard Drawings* should be developed, adopted or revised, the FLHO and Divisions or Functional Discipline Teams will agree upon a responsible Division or Functional Discipline Team to perform the preparatory work.

The responsible Division or Functional Discipline Team will develop or modify *Standard Drawings* on the CADD system. The responsible Division or Functional Discipline Team will then submit proposed new or revised *Standard Drawings* to the FLHO. Any Special Contract Requirements for the *Standard Drawings* should accompany the distribution. Normally, the submission to the FLHO should be in electronic format and include five printed copies. The responsible Division or Functional Discipline Team will coordinate the review and comment of proposed *Standard Drawings* with the other Functional Discipline Teams and/or other FLH Divisions.

The following process shall be used for approval of proposed new standard drawings and revisions to approved standard drawings:

- On behalf of the FLHO the responsible Division or Functional Discipline Team will make distribution of the proposed new or revised standard drawings to the appropriate headquarters offices and industry with a request for comments.

- The responsible Division or Functional Discipline Team will consolidate and review the comments from the other offices and make the appropriate revisions, with coordination of the other Functional Discipline Teams and/or FLH Divisions.

Upon disposition of comments, the responsible Division or Functional Discipline Team will resubmit the *Standard Drawings* to the FLHO. The submissions should include a summary of the disposition of comments. If needed, additional distributions will be made by the FLHO in accordance with these procedures. If additional distributions are not required, approval will be given to the responsible Division or Functional Discipline Team to finalize and date the title block of the *Standard Drawings*. The approval date or revision date to be included on *Standard Drawings* will be provided with FLHO approval.

The responsible Division office or Functional Discipline Team will distribute electronic versions of the CADD files to each Division. The files will also be posted in a centralized location for use by all offices and industry.

The FHLO will distribute a complete list of the *Standard Drawings* with the latest approval or revision dates with the approval memorandum noted above. Each Division shall ensure that latest approved *Standard Drawings* are provided in their CADD files.

In *Standard Drawings*, the lettering will be sentence case italicized True Type Verdana excluding titles and subtitles that will be vertical. Standard letter size will be 2 mm (0.08 in). Minimum letter size will be 1.25 mm (0.05 in). Use minimum letter size sparingly to ensure clear and readable plans at the scales proposed for standard size plans and letter sized abbreviated plans. Additional information is available in each Division's *CADD Users Manual*.

9.4.10 Engineer's Estimate

An engineer's estimate of cost is prepared for each project as part of the PS&E assembly. The estimate serves as the basis of probable construction cost and as a guide to evaluate bidders' proposals.

The estimate is a listing of all items of work in the contract, showing quantity, unit of measurement, unit cost and total cost of each. The total amount of all items of work, including appropriate incentive payments, makes up the construction estimate. Contingencies, construction engineering, project agreement costs and other costs added to the construction estimate makes up the program amount.

When a contract is financed by multiple funds, and expenditure of a fund is limited to a particular section, a separate estimate, summary sheet and bid schedule are necessary for each section. When a contract is financed by more than one type of fund, but expenditures are not limited to a particular section, only one bid schedule is necessary, supported by a combined estimate and summary sheet.

Each item of work listed in an estimate needs a description and a unique number. Each Federal Lands Highway Division office maintains a current listing of contract items with their respectively assigned descriptions and unique numbers. When the listed contract items are not applicable to the anticipated work, new items with descriptions and unique numbers will be established by the responsible party and furnished to the designer.

The unique numbers assigned to the items of work serve as input into the engineer's estimate program. This program uses the unique numbers as a basis for other related programs (e.g., bid schedule, tabulation of bids, average bid prices) and the construction progress estimate. Unique numbers will be established by the responsible party and furnished to the designer. A unique number, once assigned to an item, should not be changed.

Bridge items may not be applicable to more than one bridge or structure. Only those items physically incorporated into the bridge structure are considered bridge items. For coding purposes, the following are not considered bridge items:

- detours,
- detour structures,
- loose riprap,
- slope protection, and
- the removal of existing bridge structures.

The FLH engineer's estimate system software program is used to prepare the engineer's estimate. The designer is responsible for entering the initial pay item names, quantities and unit bid prices into the system to obtain the engineer's estimate. On-screen directions for entering the data make the program relatively easy to use. The engineer's estimate is the database for preparation of the bid schedule, bid tabulation, progress and final construction estimates using other features of the Engineer's Estimate System. A bid history database is also developed that

maintains current unit bid prices for use by the designer. The designer must evaluate the bid history data to help determine the most likely low bid for the item.

9.4.10.1 Computation of Quantities

The designer determines the contract items needed for the work. All computations for estimating quantities are a part of the supporting data. Keep the computations in support of a contract item together and the items listed in numerical sequence.

The designer may specify that some work will not be paid for directly. This work consists of small quantities that would be difficult or uneconomical to measure. Limit the no-payment work to an absolute minimum and clearly define it on the plans and in the Special Contract Requirements so that bidders can adequately include it in their cost estimates under other contract items.

A lump-sum item can is used where the work required consists of a number of inter-related, small quantity items to obtain a specified end result or the work can be described in complete detail in the Special Contract Requirements. Show a complete breakdown of the work required on the plans when a number of items are included in the lump-sum item.

The designer prescribes the work to be included in a contract, but the Construction Unit administers the method to be used to measure the work. Early coordination between the two can ensure the best method is used to estimate, measure and pay for the work.

The following sections provide many of the bid items commonly used in road and bridge construction contracts under the *Standard Specifications*, *FP-XX*. Guidance is also provided on items where it is difficult to separate quantity and payment. In addition, miscellaneous information is included to assist the designer in selection of items and how to place the items on the plans.

9.4.10.2 Division 100 General Requirements

This part of the *FP* contains general contract requirements applicable to all projects. No direct payment is made under Division 100. Within this Division, Section 109, Measurement and Payment, covers most of the details the designer should become familiar with to compute quantities.

9.4.10.3 Division 150 Project Requirements

This part of the *FP* contains project requirements applicable to all projects. Work under Division 150 will be paid for directly when there is a pay item in the bid schedule for it. When there is no work item, no direct payment will be made.

1. **Section 151 — Mobilization**. On large projects, use six to eight percent of the construction estimate rounded to the nearest $5,000 or $10,000. On small projects, use nine to ten percent of the construction estimate rounded to the nearest $1,000 or $5,000. Do not completely rely on the Engineer's Estimate system to calculate the mobilization amount. Adjust the amount by rounding off so it is a reasonable dollar value of the contract.

2. **Section 152 — Construction Survey and Staking**. Determine the bid price of this work on the basis of crew size, survey requirements and equipment to estimate hours and cost. When using average bid prices from previous contracts, ensure the survey requirements are essentially the same or the comparison will be flawed. The basis of payment under this section is lump sum, per km (mile), each, hour or other appropriate units.

3. **Section 153 — Contractor Quality Control**. This work is not measured for payment. Even though there is no payment for this work, it does cost a contractor money. It is assumed that the contractor's bid price for work under Section 154 of the *FP* includes the costs of the work under this section.

4. **Section 154 — Contractor Sampling and Testing**. The cost of the work under this section is usually based on average bid prices. Although there is considerable variance in average bid prices, an amount equal to two to two-and-a-half percent of the construction estimate will usually cover the work involved. Determine if the project requires a minimal amount or an extraordinary amount of testing in relation to the construction estimate before applying the two to two-and-a-half percent rule. The basis of payment is lump sum although other units could be used in unique and unusual circumstances.

5. **Section 155 — Schedules for Construction Contracts**. Base the cost of the work under this section on average bid prices.

6. **Section 156 — Public Traffic**. The work described in this section is measured for payment under other sections of work with one exception. If a detour is constructed and maintained under a lump-sum item, include the work under this section. If there are extraordinary complications with public traffic, adjust the prices in the appropriate section to cover the work or add additional items of work in the sections.

7. **Section 157 — Soil Erosion Control**. Work under this section covers the erosion control plan for the project. It also provides items of work necessary for the Storm Water Pollution Prevention Plan, which is included in most construction contracts.

   Most projects will have several items in the bid schedule to cover this work. A very simple project where the erosion control features can be completely detailed on the plans and described in the Special Contract Requirements may be a lump-sum item. The use of an item for soil erosion control, using a contingent sum pay unit is not permitted. In addition to lump sum, per meter (foot), each, per square meter (square yard), hectare (acre), kilogram (pound), hour and other related units are acceptable.

The past practice for developing erosion control is no longer adequate for today's requirements. The current emphasis is to retain all sediments within the construction limits and stabilize them in place.

Evaluate every cutslope, embankment, stream crossing or other disturbance, and determine what effort and devices are required to stop sediment from escaping beyond the construction limits. Transcribe this evaluation to the erosion control plan. If a stage construction concept is being considered, evaluate each stage of the work to arrive at an adequate erosion control plan.

Consider the items in the *FP* as a good beginning for erosion control devices. Do not hesitate to propose additional methods of controlling erosion and sedimentation. Not all temporary and permanent erosion control features need to be addressed under Section 157. They can be incorporated into other sections of work if it is more appropriate.

9.4.10.4 Division 200 Earthwork

1. **Section 201 — Clearing and Grubbing**. The design program computes quantities for clearing and grubbing and provides subtotals as desired by sheet total or 350-m (1500-ft) intervals or as user defined. These subtotals are placed on the profile part of the plans or on a separate tabulation of quantities to the nearest 0.01 hectares (0.01 acres). It may be necessary to round the subtotals so the total shown on the plans equals the design program output. Compute the acreage of any isolated areas and road approaches of significant size or measure the areas by planimeter or CADD. Show this quantity on the plans with the mainline roadway quantities using an appropriate note.

   On the supporting data sheet, show the design program total plus any manually computed hectares (acres). The total of these hectares (acres) is the plan quantity shown on the Summary of Quantities sheet of the plans. Add an allowance so the bid schedule quantity reflects the next tenth of a hectare (acre). If there is a large number of hectares (acres), rounding up more than a tenth of a hectare (acre) as appropriate. If lump sum is used as a payment, show the number of hectares (acres) used for the lump sum calculations on the Summary of Quantities sheet or other plan sheet.

2. **Section 202 — Additional Clearing and Grubbing**. Although the design program can be used to compute hectares (acres) under this section, it is seldom worth the effort. Manual computations are usually faster and easier. Follow the rounding guidance under Section 201 for hectare (acre) pay units.

   Plan and bid schedule quantities are usually the same. Quantities for removal of individual trees and individual stumps are usually estimated during one of the field reviews.

   If a field estimate is not available, allow 5 m^2 (5 yd^2) for removal of individual trees in sparsely forested areas, and 10 m^2 (10 yd^2) on projects in heavy timber areas where

large numbers of leaning trees and snags exist. These figures are appropriate for a 6 km to 8 km (4 mi to 5 mi) grading project.

3. **Section 203 — Removal of Structures and Obstructions**. Computations of quantities under this section are typically obtained from the survey notes or from measurements taken at the field reviews. If average bid price data is not available for the work proposed, use equipment rental rates, labor rates and overhead and profit margins for the estimate. There is a tendency to underestimate the time to remove structures and obstructions, therefore, be somewhat liberal in estimating the number of hours to perform work.

   Use this section where the work consists of salvaging, removing and/or disposing. If the work consists of removing and reincorporating or resetting an item on the project, put the work under the applicable section (e.g., removing and resetting guardrail) is provided for under Section 617 of the *FP*.

4. **Section 204 — Excavation and Embankment**. The design programs provide a listing of the mainline quantities for a project. Manually compute or estimate additional quantities outside the normal roadway prism. Insert these quantities into the design program as an "added quantity" so they can be included in the mass figures. Show excavation quantities on the plans and show the totals on the Summary of Quantities Sheet.

   Show the design program total on the supporting data sheet total plus any added quantities. This total is the plan quantity shown on the Summary of Quantities Sheet. Add about ten percent to obtain the bid schedule quantity. The allowance used should round the bid schedule amount to an even 1,000 m^3 (1,000 cy^3).

   When computing quantities for borrow, topping or embankment, use an appropriate shrink or swell factor to arrive at the quantity required to obtain the computed volume in the roadway. For borrow and topping, add about a five percent allowance to obtain an even 500 m^3 (500 cy^3) bid schedule quantity. The plan quantity and bid schedule quantity for embankment construction, furrow ditches and rounding cutslopes does not usually require an allowance.

5. **Section 205 — Rock Blasting**. Although few projects have a pay item for this work, it is still necessary to estimate the amount of controlled blast hole required to arrive at the correct unit price analysis for roadway excavation. Use the average height of the rock face times the length, and 1 or 1.5 m (3 or 5-ft) spacings to arrive at the estimated meters (feet) of the blast hole. Round the figure to the nearest 50, 100 or 500 m (50, 100 or 500 ft) depending on the quantity. Rounding within the original computations so the plan and bid schedule quantity is the same.

6. **Section 206 — Watering for Dust Control**. Estimate the number of expected days requiring dust control and multiply by an appropriate number of cubic meters (cubic yards) units per day. Climate, traffic volumes and soil conditions have major effects on this item. Construction records from previous projects in the area are very helpful in

estimating quantities. The plan quantity and bid schedule quantity should be the same. Round within the original computations.

7. **Section 207 — Earthwork Geotextiles**. Compute the square meters (square yards) of coverage required. For small quantities of less than 3000 m^2 (3,000 yd^2), add about ten percent to round to the nearest 100 m^2 (100 yd^2). On quantities over 3,000 m^2 (3,000 yd^2), add five percent and round to nearest 500 m^2 (500 yd^2).

8. **Section 208 — Structure Excavation and Backfill for Selected Major Structures**. Compute the quantities of structure excavation, foundation fill, structural backfill and structural backfill for walls as detailed in the *FP*. Add a small allowance to obtain an even 10, 50, or 100 m^3 (10, 50 or 100 cy^3) for the bid schedule quantities.

   In many instances, it is the Structures Section's responsibility to compute these quantities. The quantities are usually shown as contract quantities. The Structures Section will provide quantities needed for shoring and bracing and cofferdams.

9. **Section 209 — Structure Excavation and Backfill**. Although there is no pay item for work under this section, it is necessary to compute the quantities for bidders to use in estimating costs. This is particularly true with culverts where the estimated excavation is shown on the Drainage Summary Sheet.

10. **Section 211 — Roadway Obliteration**. Compute areas by any acceptable method including planimeter. Add about ten percent and round to 100, 500 or 1000 m^2 (100, 500 or 1000 yd^2) depending on quantities. When using a lump-sum pay unit, show the approximate square meters (square yards) of obliteration on the plans.

11. **Section 212 — Linear Grading**. The measurement unit for this work is by station. However, show the design earthwork quantity in cubic meters (cubic yards) on the plans for the bidders information. Without a good history of average bid prices, use the cubic meter (cubic yard) quantity to determine the unit price, which is then converted to stations. Round this item to the nearest 0.001 station. It is almost always a contract quantity.

12. **Section 213 — Subgrade Stabilization**. Compute quantities by the square meter (square yard) or metric ton (ton) as appropriate. Round square meter (square yard) computations to 100 or 5,000 m^2 (yd^2). Round metric tons (ton) to 10 metric tons (tons).

9.4.10.5 Division 250 Structural Embankments

1. **Section 251 — Riprap**. Measurement of riprap is cubic meter (cubic yard) or metric ton (ton). Add at least ten percent allowance to obtain an even 50, 100 or 500 m^3 (yd^3) or metric tons (tons) is the bid schedule. Show the class of riprap on the plans by one or all of the following methods:

- by tables,
- on special typical sections for riprap, and
- on the Drainage Summary if riprap is associated with culvert work.

Excavation for toe trenches is seldom paid for directly; however, show quantities on the plans for informational purposes. Where toe trenches are excavated under an existing structure or adjacent to piers, etc., that involve structural excavation under Section 208, it may be appropriate to include toe trench excavation for payment under Section 208.

The supporting data sheet should have a list or table of riprap showing locations, elevations of top of riprap, class, quantity of riprap and quantity of the trench excavation.

2. **Section 252 — Special Rock Embankment and Rock Buttress**. The measurement of rock embankment is cubic meter (cubic yard) or metric ton (ton). Add at least ten percent allowance to obtain an 10, 50 or 100 m^3 (yd^3) or metric tons (tons) in the bid schedule. Show the rock embankment on the plans by one or all of the following methods:

   - by tables,
   - on special typical sections for rock embankment, and
   - on the drainage summary if rock embankment is associated with culvert work.

   Excavation for toe trenches or embedment is not paid for directly; however, show quantities on the plans for informational purposes.

3. **Section 253 — Gabions**. Measurement of gabions is square meter (square feet) or cubic meter (cubic yards) in place. Only minor rounding of about 50 m^2 (50 yd^2) or 10 m^3 (10 yd^3) is required.

   Show gabion elevation and cross section views on the plans. Plan views are helpful where there are variations in the face of wall distance to a reference line. Tables on the plans showing station-to-station, wall quantities and excavation are appropriate.

4. **Section 254 — Crib Walls**. Follow the guidance for gabions.

5. **Section 255 — Mechanically Stabilized Earth (MSE) Walls**. Follow the guidance for gabions.

6. **Section 257 — Alternate Retaining Walls**. Although the measurement for this work is lump sum, provide the estimated square meters (square feet) for informational purposes.

9.4.10.6 Division 300 Aggregate Courses

1. **Section 301 — Untreated Aggregate Courses**. The method of measurement under this section is cubic meter (cubic yard), metric ton (ton) or square meter (square yard).

Compute the compacted volume of the material to be placed on the roadbed by using the dimensions shown on the Typical Section Sheet. In addition, compute the compacted volumes for widened areas, approach roads, parking area and tapers for channelized intersections.

To determine the hauling vehicle volume, multiply the compacted volume by 1.33. To determine metric tons (tons):

a. Multiply the compacted volume by 1.33, then

b. Convert to metric tons (tons) by multiplying by 1.65 metric tons/m^3 (1.14 tons/yd^3). (If the material is pugmill mixed, compensate for the mixing water by multiplying by 1.06).

The 1.65 metric tons/m^3 (1.14 tons/yd^3) factor applies to aggregate with a specific gravity of around 2.70. For sources with significantly different specific gravity, it is appropriate to multiply the 1.65 (1.14) factor by the known specific gravity divided by 2.70.

The quantities for crushed aggregate base are usually shown on a Tabulation of Quantities Sheet in the plans. Show the rate of application in metric tons (tons) or cubic meters per kilometer (cubic yards per mile) or per square meter (square yard) for the bidder's information. Also, specify if the quantities include the six percent water additive.

Aggregate by the cubic meter (cubic feet) = (Average W)(D)(L)(1.33)

Aggregate by the metric ton = (Average W)(D)(L)(1.33)(1.4*)(1.06**) (Metric)

Aggregate by the ton = (Average W)(D)(L)(1.33)(0.118*)(1.06**) (US Customary)

Where:

W = Width in m (ft)
D = Depth in m (ft)
L = Length in m (ft)

* Metric tons/m^2 (tons/ft^2)

** Six percent allowance for mixing water where a pugmill is required.

When the maximum dry density is available from the lab reports, multiply the compacted volume by the dry density and convert to metric tons (tons).

Multiply the aggregate by the area, m^2 (ft^2) = (W)(L)

If square meter (square yard) measurement is used, show the exact limits used to arrive at the quantities on the Typical Section. Where measurement is by the square meter (square yard), compute the cubic meters (cubic yards) or metric tons (tons) to provide bidders with an application rate.

Add a five to ten percent allowance to quantities measured by the metric ton (ton) or cubic meter (cubic yard) so the bid schedule quantity is an even 500 m^2 or 1000 m^2 (500 yd^2 or 1000 yd^2) or metric tons (ton). Square meter (square yard) measurements require very little allowance as the limits are pretty well predetermined on the Typical Sections. Round up to an even 1000 m^2 (1000 yd^2) for the bid schedule.

2. **Section 302 — Treated Aggregate Courses**. Compute quantities for this section similar to Section 301 for metric tons (tons) or square meters (square yard).

3. **Section 303 — Road Reconditioning**. Measurement under this section is kilometers (miles) or square meters (square yard). Use kilometers (miles) for mainline work and side roads where widths are relatively constant. Use square meters (square yard) for parking areas and other oddly shaped areas or for very small quantities of work. Round kilometers (miles) to the nearest 0.01 km (0.01 mi) for the bid schedule. Add five to ten percent to the square meter (square yard) to obtain an even 100 m^2 or 500 m^2 (100 yd^2 or 500 yd^2) in the bid schedule.

4. **Section 304 — Aggregate Stabilization**. Measurement for aggregate stabilization is kilometers (miles) or square meters (square yard). Follow the guidance under Section 303 to compute quantities.

   Provide an allowance for chemical additives so the bid schedule quantity comes out to an even 10, 50 or 100 metric ton (ton) quantity.

5. **Section 305 — Aggregate/Topsoil Course**. Measurements under this section include metric ton (ton), square meter (square yard), cubic meter (cubic yard) or meter (feet). Provide an allowance to round the bid schedule amount to an even 10, 100 or 500 units as appropriate.

6. **Section 306 — Dust Palliative**. Measurement for the dust palliative application is the kilometer (mile) or square meter (square yard). Very little allowance is needed. The dust palliative material is measured by the metric ton (ton). Add a five to ten percent allowance to get an even 10, 50 or 100 metric ton (ton) bid schedule quantity.

7. **Section 307 — Stockpiled Aggregates**. Measurement for stockpiled aggregate is the metric ton (ton) or cubic meter (cubic yard). Usually the amount has been predetermined and no allowance is necessary.

   The preparation of stockpile sites is measured by the hectare (acre). Provide an allowance so the bid quantity shows a whole hectare (acre).

8. **Section 308 — Minor Crushed Aggregate**. Measurement is based on cubic meter (cubic yard) or metric ton (ton). Be liberal in estimating quantities so that only minimal, if any, rounding is required for the bid schedule quantity.

9. **Section 309 — Emulsified Asphalt Treated Base Course**. The measurement for this section is metric ton (ton) or square meter (square yard). Compute metric tons (ton)

accordingly to the guidance under Section 301. For square meters (square yard), use length times width. Show the exact limits used in the computations on the Typical Section. Only a minor allowance should be used with square meters (square yard). Round up to an even 1000 m^2 (1000 yd^2) for the bid schedule.

9.4.10.7 Division 400 Asphalt Pavements and Surface Treatments

1. **Section 401 — Hot Asphalt Concrete Pavement Through Section 407 — Open-Graded Emulsified Asphalt Pavement**. Measurement under these sections is the metric ton (ton). Compute the compacted cubic meter (cubic foot) volume of the material to be placed on the roadway using the dimensions shown on the Typical Section Sheet. In addition, compute the volumes for widened areas, approach roads, parking areas and tapers for channelized intersections.

   For dense graded mixes, multiply the volumes by 2.30 metric tons/m^3 (0.07 tons/ft^3) to obtain tonnage. This factor assumes a plant mix mass unit weight of 2300 kg/m^3 (143.6 lb/ft^3).

   Asphalt Pavement for metric tons (tons) = (Average W)(D)(L)(2.30*) (Metric)
   Asphalt Pavement for tons = (Average W)(D)(L)(0.06*) (US Customary)

   Where:

   W = Width in m (ft)
   D = Depth in m (ft)
   L = Length in m (ft)

   * The maximum density obtained from the lab reports may be substituted for this factor in the equation.

   For open-graded mixes, multiply the volume by the metric ton per cubic meter (ton per cubic foot) factor obtained from the Materials Section. The unit mass density of a cubic meter (cubic foot) of open-graded mix is considerably less than dense graded-mix.

   To the total of the above quantities, add an allowance of three to five percent to obtain an even 500 or 1,000 metric tons (tons) in the bid schedule quantity.

   When the asphalt is a separate pay item, use six percent of the metric tons (tons) of asphalt base or pavement mix for dense-graded mixes. Check with the Materials Section for any significant differences on a particular project. For open-graded mixes, the Materials Section will provide recommendations on percentages. If asphalt quantities are based on rounded quantities of base or pavement quantities, very little additional rounding is necessary. Rounding to an even 5 or 10 metric tons (tons) is usually sufficient.

2. **Section 408 — Cold Recycled Asphalt Base Course**. The measurement for this section is metric ton (ton) or square meter (square yard). Compute metric tons (tons) according to the guidance under Sections 401 through 407. For square meters (square yard), use length times width, and show the exact limits used in the computations on the Typical Sections. Only a minor allowance should be used with square meters (square yard). Round up to an even 1,000 m^2 (1,000 yd^2) for the bid schedule quantity.

3. **Section 409 — Asphalt Surface Treatment**. Measurement is by the metric ton (ton) or cubic meter (cubic yard) under this section. Compute metric tons (tons) according to the guidance under Sections 401 through 407. For square meters (square yard), use length times width and show the exact limits used in the computations on the Typical Sections. Only a minor allowance should be used with square meters (square feet). Round up to an even 1000 m^2 (1000 yd^2) for the bid schedule.

4. **Section 410 — Slurry Seal**. Measurement is by the square meter (square yard). Round quantities according to Section 408 above. The quantities of aggregate and asphalt should be calculated for the unit price analysis unless there is a good bid history of average bid prices.

5. **Section 411 — Asphalt Prime Coat**. Measurement under this section is metric ton (ton) or liter (gallon). Compute the quantity of asphalt using an application rate of 1.5 L/m^2 (0.038 gal/ft^2) for cut-back asphalt and 1.1 L/m^2 (0.027 gal/ft^2) for emulsified asphalt. To convert liters (gallons) to metric tons (tons), use 1,040 L/t (303 gal/ton) for cut-backs and 1,000 L/t (291 gal/ton) for emulsion. Round to an even 10 metric tons (10 tons) or 5,000 L (5,000 gal) for the bid schedule.

   For blotter material, use 10 kg/m^2 to 14 kg/m^2 (2 lb/ft^2 to 3 lb/ft^2). If an inverted prime is desired, use 19 kg/m^2 (4 lb/ft^2). Round to an even 10 metric tons or 100 metric tons (10 tons or 100 tons) for the bid schedule.

6. **Section 412 — Asphalt Tack Coat**. Measurement is based on metric ton (ton) or liter (gallon). Use an application rate of 0.35 L/m^2 (0.008 gal/ft^2) for plan quantities. Round to an even 5 metric tons or 10 metric tons (5 tons or 10 tons) or 5,000 liters (5,000 gallons) for the bid schedule.

7. **Section 413 — Asphalt Pavement Milling**. Measurement is based on square meter (square yard) or kilometer (mile). Round square meters (square yard) up to an even 1,000 in the bid schedule. Round length to 0.01 km (0.01 mi).

8. **Section 414 — Asphalt Pavement Crack and Joint Sealing**. Measurement is based on liter (gallon), kilogram (pound) and meter (foot). It is difficult to estimate the exact amount of work that will be required in the field under this section. Be liberal in estimating the estimate of work so that only minimal, if any, rounding is required for the bid schedule quantity.

9. **Section 415 — Paving Geotextiles**. Measurement is based on square meter (square yard) and metric ton (ton). Be liberal in estimating the quantities of work so that only minimal, if any, rounding is required for the bid schedule quantity.

9.4.10.8 Division 500 Portland Cement Concrete Pavement

1. **Section 501 — Portland Cement Concrete Pavement**. Measurement is based on the square meter (square yard). Compute quantities fairly accurately for this work so rounding is minimal.

2. **Section 502 — Portland Cement Concrete Pavement Restoration**. This is a catch-all section for repair of concrete pavement. There is a tendency to be conservative in estimating this type of work. Therefore, assume a generous amount of work and use only minor rounding for bid schedule quantities.

3. **Section 503 — Portland Cement Concrete Base Course**. Follow the guidance under Section 501.

9.4.10.9 Division 550 Bridge Construction

Sections 551, Driven Piles through 565,Drilled Shafts of the *FP* contains the bridge construction work items. The Structures Section generally determines bridge work items and their respective quantities. The Structures Section will provide the items of work, the quantity of work and the estimated cost for the work for inclusion into the contract package.

Insert the costs provided by the Structures Section into the engineer's estimate system. Allowances are not usually added to bridge items.

9.4.10.10 Division 600 Incidental Construction

1. **Section 601 — Minor Concrete Structures**. For cubic meter (cubic yard) measurement, compute the volumes either from rates on standard plans or manually compute the quantities to the nearest 0.1 m^3 (0.1 yd^3). Add an allowance to round the bid schedule amount to an even cubic meter (cubic yard). Round square meter (square yard) measurements to the nearest 1, 5 or 10 units.

   Where concrete is not measured for payment directly, estimate the quantity and show it on the plans for the benefit of the bidders. With footings, uniform height walls, etc., showing concrete plan quantities to three decimal places will assist bidders.

2. **Section 602 — Culverts and Drains**. List all culverts on the Drainage Summary Sheet. Show the pipe sizes, lengths and sections, bevels, structure excavation, acceptable alternates, etc. Add a cross section to the plans for pipe larger than 1,200 mm (4 ft) in

diameter or equivalent diameter showing inlet and outlet elevation, design Q, end treatments, flow grade line, energy dissipators, etc.

Small culverts for approach roads and for cross-drains should have an allowance due to normal changes that occur in the field during staking and construction. The allowance depends on the type of construction, terrain and rainfall in the area. No allowance is necessary for larger culverts.

3. **Section 603 — Structural Plate Structures**. These structures have site-specific designs. The design is the responsibility of the Hydraulics Unit and their criteria should be incorporated into the plans. No allowance is necessary under this section.

4. **Section 604 — Manholes, Inlets and Catch Basins**. The location, size, type, etc., should be shown on the plans and on the Drainage Summary Sheet. These items require Special Drawings or *Standard Plans*. In many instances, the roadway owning agency will request that their *Standards* be used for consistency with their highway system. No allowance is necessary under this section.

5. **Section 605 — Underdrains, Sheet Drains and Pavement Edge Drains**. The pay item for perforated underdrain may be modified to include the geotextile and the backfill. An allowance is appropriate for underdrain.

6. **Section 617 — Guardrail**. Compute lengths of W-beam guardrail for individual locations in multiples of 3.81 m (12.5 ft). Round the quantity to an even 5 or 10 m (25 ft). Guardrail is generally shown in a table on a separate plan sheet but it is permissible to show it in a straight line diagram along the top of the profile section of the plan sheets.

   Prepare a table for the supporting data showing station-to-station, guardrail left or right, length in meters (feet), terminal section type, etc. Exclude the length of terminals.

7. **Section 618 — Concrete Barriers and Precast Guardwalls**. Compute cast-in-place or slip form barriers to the nearest meter (foot) and round for the bid schedule. Precast barriers should be computed in multiples of the length specified for the precast unit; normally 3 m (10 ft). Show this work on the plans and in the supporting data as indicated under Section 617.

8. **Section 619 — Fences, Gates and Cattle Guards**. Measurement of fencing is generally by the length (m (ft)) of slope measurement. Compute the horizontal length of fencing along the proposed fence alignment and adjust this length for the average slope of the ground.

   Fencing is usually shown on a tabulated format or on a separate plan sheet. The proposed fence may also be shown on the plans by a straight line at the top of the profile on the Plan and Profile Sheets, with the type and length of fence labeled.

   The supporting data sheet should have a table showing fencing by station-to-station, left or right and horizontal length.

To the plan total, add an appropriate allowance to bring the bid schedule to an even 10, 50 or 100 m (50 or 100 ft).

Show proposed gates on the straight line with the fence at the top of Plan and Profile Sheet or tabulated on a separate plan sheet.

Show cattle guards on the plan with a note indicating station, type, length and the appropriate references to *Standard Plans*.

9. **Section 622 — Rental Equipment**. Approach the work under this section in the same manner as work under a lump-sum item. Determine what work is required under equipment rental and then determine the size and type of equipment needed to do the work. Try to specify the equipment type and size that is common to the work required for the remainder of the contract.

10. **Section 623 — General Labor**. Determine the work required under this section and estimate the number of hours that it takes to accomplish the work. The *Means Heavy Construction Cost Data Book* provides crew sizes and hours to perform several hundred different tasks. It is a good reference if there is no history for the specific work desired under this section. The Cost Data Book is on file in the Technical Services Engineer's office.

11. **Section 624 — Topsoil**. Usually the design quantity depends on the availability of topsoil on the project within cut and fill limits. This is often an insufficient quantity to topsoil the whole project, so the plans should show which slopes are to receive topsoil. The topsoil is normally placed in 75 mm to 100 mm (3 in to 4 in) loose depth on flatter slopes (flatter than 1:1.5). Specify the depth on the Typical Section Sheet or on a special landscape drawing.

    Where conserving topsoil from roadway excavation or beneath embankment areas, remember to replace the material removed and use for topsoil by roadway excavation. Make the appropriate grade or slope changes to compensate for the removed topsoil.

12. **Section 625 — Turf Establishment**. The design programs compute quantities for areas to be seeded on the mainline. For isolated areas and areas of old roadway obliteration, manually compute the areas by multiplying average widths (m (ft)) by average lengths (m (ft)) to obtain the area (square meters (square feet)). Then convert to hectares (acres) by multiplying by .0001 (.000023). Where using slurry units, assume 10 slurry units per hectare (per acre). Seeding may be shown on the plans at the bottom of the profile at regular intervals, by sheet total or by tabulation on separate plan sheets. Plan quantities should be shown in even units. Round the plan total by adding a small allowance to bring the bid schedule to an even hectare (acre). Round slurry units to 10 units.

13. **Section 633 — Permanent Traffic Control**. Show sign location, *MUTCD* number, legend, size, area (m^2 (ft^2)) and post size on the plans. Tables summarizing sign

quantities should be shown on the plans. The supporting data sheet may refer to the tables on the plans.

Delineators are generally shown with a straight-line diagram or a plot of the alignment on a scale that will fit on a plan sheet. Use symbols to indicate locations of posts left and right. The diagram used is acceptable as the supporting data sheet. To determine the spacing of delineators, refer to *Standard Plans* or to the *MUTCD* section on traffic markings. Little or no allowance is added to the plan total for delineators.

14. **Section 634 — Permanent Pavement Markings**. Show traffic markings on the plans either by line diagrams for the entire project or by tables. Specify the beginning and ending stations of no-passing stripes and the total quantities of broken and solid striping. Round plan totals by adding an allowance that is appropriate to cover connections and intersections. The supporting data sheet may refer to the plans.

15. **Section 635 — Temporary Traffic Control**. Show all 635 items on traffic control plans. Identify the locations for installing construction signs and specify the uses for the barricades, cones and warning lights shown. Quantities for traffic control devices are summarized on the traffic control plans or on separate plan sheets.

    See Chapter 8 for temporary traffic control plan details. Where extensive detours are required, show the design alignment, grade and surfacing requirements on the plans.

    After determining the contract time and number of days for major work, compute flagging hours and pilot cars hours. Supporting data sheets for other traffic control items may refer to the plans and be shown on one sheet.

    These guidelines do not cover all the sections of the *FP*. Do not hesitate to ask for directions on any work involved in the contract, including acceptable methods of computation of quantities.

9.4.10.11 Computation of Contract Time

Designers must allow reasonable times for completion of construction projects. Factors that determine contract time include materials, equipment, manpower, costs and constraints (i.e., weather, regulations, traffic, utilities, user convenience).

Under the current *Standard Specifications*, contract time may be based either on a calendar day or be a fixed completion date. Generally, specify contract time on a calendar day basis.

There are four basic methods of determining contract time that are in general use throughout the highway industry. They are as follows:

1. **Construction Season Limits**. The contract time ends at, or shortly follows, the end of the construction season. This is a very effective approach on surfacing and paving

projects, small bridges and similar types of construction. The contract time must begin early in the year to ensure materials are available and time frames are reasonable.

2. **Quantity or Production Rates**. This method determines contract time by allowing a daily production rate for each controlling item of work in the contract that significantly affects the project time. The concept could allow time for every item of work, but this is generally not necessary as many minor items are completed concurrently with the more costly items of work. Experience and past data from completed projects helps in establishing the production rates used.

3. **Work Flow Techniques**. Determining contract time under this method involves preparation of a bar or progress chart on normal projects to developing full critical path method (CPM) analysis on large complicated projects. A CPM plan requires extensive coordination of materials, equipment, personnel and administrative support. The more complicated this technique becomes, the more dependent it is on experience, judgment and data sources.

4. **Estimated Costs**. Under this method of determining contract time, the contract costs relate to time or working days (e.g., contractor expected to earn $15,000 per working day over life of the contract). Using this method requires an accurate and current database.

   Any or all of the above methods are acceptable. It is not unusual to combine a bar time chart with production rate analysis on a project. The designer should use the method or combination of methods that are most practical using the databases available.

9.4.10.12 Development of Prices

The engineer's estimate reflects the actual cost to the contractor of doing business, including a reasonable profit. There are two methods commonly used to determine this cost; historical costs (bid based estimating) and actual costs (cost based estimating). With either method, the designer strives to target the expected low bid.

1. **Bid-Based Estimating**. This method uses historical bid data as a basis for estimating current costs. Low bids received for projects (within the past two to five years) under similar conditions usually represent the contractor's cost plus a reasonable profit for those projects. The low bid is generally the best indicator of the expected actual cost for a project. The average of the low bids received on previous projects in similar locations should be the basis for current projects.

   Each engineer's estimating software in each Federal Lands Highway Division office provides a listing of unit bid prices on contract items from previous projects. Typically, only the low bid on each similar project should be used to develop unit prices (average bids inflate prices above the low bid). However, the bids from the lowest three bidders are generally considered to ensure the low bid is reasonable. The designer should use

these prices and modify them to fit the conditions on the project. Allow for any factors that may have a direct bearing on the prices. These would include the following factors:

- availability of construction material;
- proximity of access roads;
- railroads; and
- distance from towns, traffic, time of construction, inflation, quantities, etc.

The historical bid price approach, tempered with engineering judgment, works quite well with almost all of the minor items of work on a project.

2. **Cost-Based Estimating**. Some items of work that may not lend themselves to the average bid price approach are major items of work (e.g., roadway excavation, base and plant mix material, bridge material). These items require a supporting analysis to ensure that all factors that bear on the cost of the item receive consideration. Cost based estimating uses current labor, equipment and materials costs as well as overhead and profit to develop unit prices.

   The following are important steps in developing prices for cost estimating:

   - Determine if the proposed unit prices are realistic for the location, time of year and characteristics of the work to be performed. Support unit prices for major items of work by an analysis prepared in sufficient detail to ensure that all factors that bear on the cost of the item have been considered. Estimated unit prices are generally based on historical data (e.g., the unit prices used for previous estimates, the corresponding bid prices on previous contracts). Review these prices at regular intervals to determine if pricing changes are needed to reflect current trends.

   - Consider factors that can affect the estimated cost of a project (e.g., labor rates, equipment rates, unusually large quantities, interest rates, time allowance, competition levels, material shortages). Adjust any historical prices accordingly.

   - Confirm that the bid data prices to be used are current. Update, if necessary.
   - Document the methods and assumptions used to establish each unit price. The bid evaluation process will rely heavily upon this documentation to determine if all factors effecting the reasonableness of the bid have been considered.

9.4.11 Specifications

Specifications are the compilation of directions, provisions and requirements about the quality and performance of the work. They should describe the work with clarity and precision and have a clear logical format.

Specifications should not specify impossibilities, near impossibilities or contain unenforceable requirements. When ideal conditions cannot be obtained, specify tolerances to permit acceptable variations in the work.

All specifications fall into three general categories:

1. **Performance or End Result Specifications**. These specifications give the contractor the entire responsibility for supplying an item or a product for construction that meets the specification requirements. The specification generally places no restrictions on the materials used or the methods of incorporating them into the completed work. This type of specification is suitable for use when the end product is measurable, when a quick method of testing is available and when deficiencies are correctable by reprocessing or reworking.

2. **Materials and Methods Specifications**. These specifications are suitable for use when the end product characteristics are unknown or are not measurable. They also apply when no quick method of acceptance test is available, or it is impractical to remove and replace the defective work. Use of these specifications directs the contractor to combine specified materials in definite proportions using approved equipment or to place a specified material or product in a specified way. Normally, the operations are always under government supervision and control.

3. **Restricted Performance Specifications**. These specifications are the most widely used type. They allow the contractor the fullest possible latitude in obtaining the desired end result as stated in the contract. However, they contain certain restrictions to ensure an acceptable level of quality and prevent the construction or production of a large quantity of defective work. In most cases, restrictions on a performance specification does not relieve a contractor of all responsibility. These specifications ensure a minimum acceptable quality and they also give the contracting officer some basis on which to administer the contract and accept the work.

9.4.11.1 Types of Specifications

Under the three general categories, there are three distinct types of specifications used by Federal Lands Highway Division offices for contracts, and each has its place in the hierarchy of contract documents.

1. **Standard Specifications**. The *Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects* approved for general application and repetitive use.

2. **Supplemental Specifications**. Additions and revisions to the *Standard Specifications*.

3. **Special Contract Requirements**. Additions and revisions to the Standard and Supplemental Specifications applicable to an individual project.

See the glossary in Chapter 1 for their definitions and relationship with each other and interaction with the other parts of a contract.

The FLH Specification Coordination Group (SCG) is responsible for the maintaining and updating of the *Standard Specifications* (current edition of the *FP*). FLHO may issue Supplemental Specifications, which are to be incorporated in all applicable FLH contracts until the Supplemental Specifications are included in a *Standard Specifications* update. The designer is responsible for the initial preparation of all Special Contract Requirements relating to conditions peculiar to an individual project. Special Contract Requirements are specifications which add to, delete, modify or revise the *Standard* or Supplemental *Specifications*. This section will describe the methods and techniques for developing and writing Special Contract Requirements.

The contract specifications will sometimes refer to a specification, standard or test method adopted by a recognized technical association. Some of the recognized associations follow:

- American Association of State Highway and Transportation Officials (AASHTO).
- American National Standards Institute (ANSI).
- Association of Official Agricultural Chemists (AOAC).
- American Road and Transportation Builders Association (ARTBA).
- American Society for Testing and Materials (ASTM).
- American Wood Preservers Association (AWPA).
- American Welding Society (AWS).
- American Water Works Association (AWWA).

Occasionally, a contract may use State transportation agency specifications. This can range from total use of State specifications to allowing some State-specified methods or products to be acceptable alternatives to Federal requirements.

Government specifications and standards used by reference include the following:

- Federal specifications and standards approved for use by the General Services Administration.

- Voluntary products standards published by the National Institute of Standards and Technology, US Department of Commerce. Standards published before 1966 are referred to as “Commodity Standards” or “Simplified Practice Recommendations.”

- Military standards approved for use by the US Department of Defense.

When the contract lists or refers to a specification, standard or test method of an accepted association or other government agency, the specification standard or test method cited becomes a part of the contract. Citing these documents has the same legal effect as though every word of the specification, standard or test method had been written in the contract.

Ensure the specifications incorporated into the contract by reference do not conflict with other contract documents.

9.4.11.2 Developing Special Contract Requirements

These requirements provide additions and revisions to the *Standard* or Supplemental Specifications. Begin by analyzing the material, process or work proposed in the contract.

Assemble existing specifications prepared for the same or similar subject and obtain specifications for materials and processes prepared by standardizing organizations or State agencies. A study will reduce the time needed for research and preparation of the specifications.

If possible, do not specify brand name or proprietary products. When brand names or proprietary items have to be specified, list a minimum of three acceptable sources for the material or product desired. Sole source procurement is to be avoided. Cover the important properties of materials but do not load the specifications with minor restrictions, which may be difficult or impossible to meet.

Specifications from national technical associations are a valuable source of authoritative information. When specifying standards or test methods, identify them by their identification number (e.g., ASTM A 307, AASHTO T 27, AASHTO M 31M, Federal Specification TT-P-641). Do not include the year portion of the identification number. (Example: When specifying AASHTO T 27-87I use AASHTO T 27 and drop the 87I, which says the specification is an interim specification adopted for use in 1987.) An “M” after the standard number indicates a metric specification and should be included in the reference.

A reference made to a specification, standard or test method adopted by AASHTO, ASTM, GSA or other recognized national technical association, means the approved procedures that are in effect on the date of the contract solicitation.

When adopting requirements taken from other specifications, ensure they are appropriate for the conditions in the current project. The use of a specification on a previous project does not mean it will be satisfactory for the present project. Check the criteria to ensure it is relevant, realistic and applicable for the proposed project. Study every specification to eliminate nonessential requirements and to permit the use of new types of materials, methods or equipment. Do not repeat specification requirements for emphasis. State them firmly and only once.

Do not specifically exclude recycled materials. Recycled materials should be allowed to compete with virgin materials at least on an equal basis. In some cases, recycled materials may be encouraged by providing incentives or relaxed specification limits.

9.4.11.3 Writing Special Contract Requirements

Use the general format for the *Standard Specifications* when writing specifications for a new item. Most standard specification sections, except Divisions 100 and Division 700, have five major subsections.

1. **Description**. This contains a short condensed statement of the work required. It may include a list of designations, which may be specified in the pay items. Do not use words such as "in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness and typical cross section shown on the plans or established by the contracting officer."

2. **Material**. Use this subsection to list the materials for the work and their applicable specifications. Wherever possible the Materials subsection should simply consist of an alphabetical listing of materials and references in tabular form. References are usually made to other sections or subsections in the contract specification or applicable specifications for materials as contained in AASHTO, ASTM, etc. The method(s) of sampling and testing and applicable acceptance procedures should be included in the acceptance subsection under Construction Requirements.

3. **Construction Requirements**. Describe the sequence of construction operations, special equipment, controls, limitations, tolerances and acceptance criteria in chronological order. Use multiple subsections with subheadings.

   Use imperative mood, active voice whenever possible. Instead of saying, "The contractor shall build the road." or "The road shall be built." say "Build the road." In sentences using the imperative mood, the contractor is implied. Actions of the government should be written in the active voice using the work "will." For example, "The government will approve the road." Subsection 101.01 of the *FP* makes this interpretation a part of FLH contracts.

   Use sufficient specification requirements to ensure quality of workmanship and satisfactory completion of the work. Minimize specific requirements about methods and equipment to permit improved equipment and to encourage contractors to apply new and advanced ideas and methods in construction. Specify the allowable tolerances and applied penalties, if any, for exceeding these tolerances.

   The last subsection under Construction Requirements is used to describe how the work under that section will be accepted. This usually includes references to the following four methods of acceptance:

   - Subsection 106.02, Visual Inspection;
   - Subsection 106.04, Certification of Compliance;
   - Subsection 106.04, Measured or Tested Conformance; or

- Subsection 106.05, Statistical Evaluation of Work and Determination of Pay Factor (Value of Work).

4. **Measurement**. Since the contractor performs the measurement under FLH contracts, use the active voice, imperative mood. Specify the components of the completed work item to be measured for payment and the units of measurement to be used. Use the measurement terms and definitions contained in Subsection 109.02 of the *FP*. Establish where, when and how to measure the work item. List any exception that will or will not be included in the measurements.

5. **Payment**. This subsection should consist of the following wording:

> *The accepted quantity, measured as provided above, will be paid at the contract price per unit of measurement for the pay items listed below that are shown in the bid schedule. Payment will be full compensation for the work prescribed in this Section. See Subsection 109.05.*

Follow this wording by a list of the pay item numbers, names and corresponding pay units.

Pay items with their unit bid prices subject to adjustment under Subsection 106.05 should be included as exceptions in the above paragraph. The subsection will also need to describe the method for adjusting the contract unit bid price.

Subsection 109.05, Scope of Payment, includes the general rules for measurement and payment of work. There is no need to restate these rules in each individual section. However, all exceptions or needed clarifications of these rules should be stated in the Measurement or Payment subsections or the individual section.

When writing a Special Contract Requirement that adds to a *Standard Specification*, use the following phrase:

*Subsection (*No.*) is supplemented as follows:*

When writing a Special Contract Requirement to delete a *Standard Specification* for a contract, use the following phrase:

*Subsection (*No.*) is deleted.*

When writing a Special Contract Requirement to replace or modify a *Standard Specification*, use the one of the following phrases:

*Delete Subsection (*No.*) and substitute the following:*

or

*Subsection (*No.*) is amended as follows:*

9.4.11.4 Fairness

Specifications should not place all the risk of construction on the contractor. To do so will, in all probability, result in high bid prices. Omissions, ambiguities or inconsistencies in the plans or specifications are not the responsibility of the contractor.

Direct reference to proprietary specifications of national, regional or local trade associations (e.g., Western Pine Association, etc.) should not be placed in the *Specifications*. Proprietary specifications are subject to change without notice to or acceptance by FHWA.

Avoid the use of trade names in the *Specifications* and on the plans. Instead, formulate *Specifications* to obtain the desired results and assure full competition among equivalent materials, equipment and methods. The Federal Acquisition Regulations (FARs) do not permit reference in the *Specifications* and on the plans to single trade name materials (refer to 23 CFR 635.411). In exceptional cases, however, the use of trade name designations are acceptable. These cases require a listing of all, or at least a reasonable number of acceptable materials or products. Generally, list at least three trade names.

A project may require a specific material or product, even though there are other acceptable materials and products. This is an acceptable procedure if the Division Engineer approves the choice as being in the public interest.

A *Specification* should clearly state the contractor's obligations and known risk. No specification should try to get something for nothing from a contractor by concealing its intent.

9.4.11.5 Clearness

Write all *Specifications* in a simple and concise style. Use short sentences, use words in their exact meaning, avoid multi-syllable words and be careful in the use of punctuation and pronouns. Avoid the use of indefinite words and phrases. Each word, each phrase and each sentence in a *Specification* should clearly convey the same meaning to every reader.

The *Specification* must describe the work with clarity and precision to prevent different interpretations by the contractor and the contracting officer. Never put anything in the *Specification* that you do not expect to enforce.

Avoid expressing more than one thought in a sentence since this leads to confusion. If a technical word will clearly describe the idea to the contractor, use it exclusively. Do not use synonyms for literary effect. Always use words in their true dictionary or technical meaning. Do not use colloquialisms and slang expressions. Syntax, the orderly or systematic arrangement of words or phrases in a sentence, is very important and the established usage should be maintained.

Punctuate carefully. Recast the sentence if a change in punctuation might change the meaning. The purpose and effect of the *Specification* should be clear from its language and the language should convey only one meaning.

Use all the words you need to convey clear and correct messages, but use no more. The choice of words is important. They should be plain and well understood.

Exhibit 9.4-X is a listing of words and phrases to avoid when writing specifications.

In addition to the words and phrases listed in Exhibit 9.4-X, use the following words in the proper context:

1. Shall/Will. Use shall when the contractor is the subject of a command or order. Better yet, use the imperative mood, active voice to avoid the use of "shall." Use "will" when the government or contracting officer is the subject.

2. May. Use may when either the contractor or government is the subject and either or both have options or alternatives.

3. Amount/Quantity. Use amount when money is the subject. Use quantity when volume, mass or other unit of measurement is the subject.

4. Bidder/Contractor. Do not use bidder in the *Specifications*. Use contractor exclusively. Bidder is reserved for use in the Notice to Bidders, press releases, amendments and other similar non-specification portions.

Do not use the words said, same, aforesaid, hereinabove, hereinafter, former, latter, whatsoever or similar words of reference or emphasis. Do not use the expressions and/or, as per, or, etc.

Avoid such terms as "as directed by the contracting officer," "to the satisfaction of the engineer," or "satisfactory to the engineer". This type of phrase may be used sparingly, such as in unit price items where action taken by the contracting officer will definitely not involve changes in cost to the contractor.

9.4.11.6 Completeness

Each *Specification* must be complete and will complement and substantiate the applicable Typical Sections, dimensions and details shown on the plans. The *Specification* should furnish all information necessary to enable a bidder to prepare a complete and responsible bid and to enable the contractor to construct the project properly. The *Specification* should never fail to give the bidders and the contractor explicit and definite instructions. However, there is no place in a *Specification* for instructions to the contracting officer.

Do not attempt to explain the reasons for requirements. This information or instructions associated with the enforcement or specifications properly belong in the *Construction Manual* or in a design narrative and not in the *Specifications*.

Do Not Use	Use
Any	All
In the event that	If or when
It is intended	Shall
Subsequent to	After
In order to	To
It shall be incumbent upon	Shall
It shall be the responsibility of the contractor	The contractor shall
It shall be the duty	Shall
Is hereby authorized	May
For the purpose of	For
Must	Shall
If the contractor so elects he may	The contractor may
At the option of the contractor	The contractor may
Is hereby amended	Is amended
Is hereby deleted	Is deleted
By means of	By
Absolutely essential	Essential
Enclosed herewith	Enclosed
At a later date	Later
Prior to	Before
In accordance with	By, under, according to
Through the use of	By
Until such time	Until
In order to	To
Engineer	Contracting officer (CO)

Exhibit 9.4-X CORRECT USAGE OF WORDS AND PHRASES

Specifications should specify materials, construction methods, sequence of work, the method of measurement and the basis of payment. Notes on the plans should explain and clarify the design features. Cover a requirement only once. Information or data that is shown on the plans should not be shown in the *Specifications*.

There should be no uncertainty by the contractor or contracting officer about the desired quality or acceptability of the work. Use only essential facts, essential words and essential phrases. Omit needless words and phrases. If a word has the same meaning as a phrase, use the word.

9.4.11.7 Correctness

Specifications should be accurate and factual. Sources of data used in the *Specification* must be reliable and current. Careless statements or statements based on unreliable data are frequently the cause of contract administration problems and contractor's claims. Legalistic words and phrases may shorten or clarify *Specifications*, but ensure that the usage is correct and that alternate interpretations cannot contradict the intended meaning.

There are many publications available for providing instruction on the preparation of specifications. The majority of the *Standard Specifications* begin as special requirements, which gradually change through use until the intent and meaning is the same to both the contractor and contracting officer.

A good guide for determining the success of a specification is to review the bid tabulations for the item in question. When the range of bidding is close, it indicates that all contractors are reading the *Specification* in the same context. Conversely, a wide range of bidding may indicate confusion and ambiguity in the *Specification*.

9.4.12 Contract Assembly

The contract assembly, often called solicitation package, is the end product of the designer's efforts. The PS&E package is an integral part of this assembly. Before the Federal Lands Highway Division offices can solicit bids for a construction contract, they need to describe the articles, works or services for a desired bid. This involves preparing plan drawings, supplemented by *Specifications* and a schedule of quantities, and combining them with appropriate regulations and clauses into a contract assembly.

A contract assembly or solicitation package consists of several main parts:

1. **Solicitation, Offer and Award (SF 1442)**. This contract form, after being signed by the contractor and contracting officer, consummates the contract and makes it legal and binding on all parties.

2. **Solicitation Provisions**. The *Federal Acquisition Regulations* (FAR) define the scope of the contract and sets forth bidding requirements.

3. **Bid Schedule**. A list of all pay items in the contract to be completed by bidders with their offered bid prices for the work. The bid schedule is prepared from data obtained from the engineer's estimate.

4. **Contract Construction Clauses**. *FAR* clauses regulating and controlling contractor construction activities.

5. **Labor Standard Clauses**. All laborers and mechanics working on the project are covered by Federal regulations (i.e., *Davis-Bacon Act*) that includes a minimum wage schedule.

6. **Special Contract Requirements**. The amendments and supplements to the *Standard Specifications* necessary for the construction of the project.

7. **Plans and Drawings**. The plans and drawings necessary to detail and identify the work. These include *Standard Plans* and Special Drawings that may be applicable.

The Federal Lands Highway offices use these seven subdivisions in their contract solicitations (advertised or negotiated). The solicitation generally contains all the necessary forms and contract documents that a bidder needs to make the government an offer for the construction of the highway facility.